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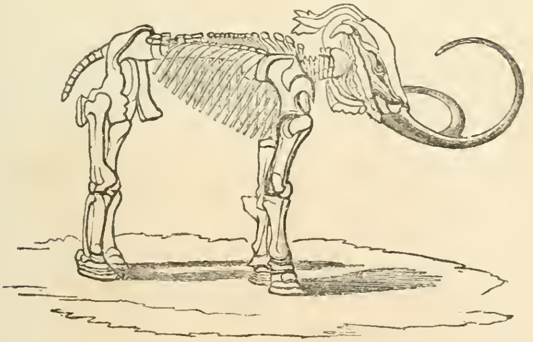
EDITED BY S. J. MACKIE, F.G.S., F.S.A.



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PREFACE.

There is one pleasure this leaf of my volume yearly affords me which to me is more grateful than any other reward I can reap from my many labours of the year gone by—the right to express my own heartfelt good wishes to my own many good friends. I wish them all happiness again, as I hope to do for many a long year to come,—even when my faltering pen shall be nerveless to express it.

For myself, I write somewhat sadly mindful of many short-comings. Goaded by my own impetuous wishes, I have sometimes promised more than time and physical strength would permit me to perform. This is my regret. But these short-comings are my own. The volume which this number closes is not less rich in valuable and novel articles than any that have preceded it. Its pages and its plates and illustrations are far more numerous—and last, not least, my list of friends and contributors is larger and more numerous too. To Professor Owen, Mr. Salter, Mr. Davidson, Mr. Prestwich, Mr. Pengelly, Mr. Woodward, Mr. Hull, Mr. Wynne, Mr. Drake, the Rev. Mr. Symonds, the Rev. Mr. Fisher, Mr. Whitaker, Dr. Hector, Mr. Roberts, Mr. Powrie, Mr. Marston, Mr. Markham, the Rev. Dr. Anderson, Mr. Macalister, Mr. Charles Moore, Mr. Salmon, Mr. C. Pratt, Lt. Hutton, Col. Nelson, Admiral Wauchope, Mr. Whiteaves, Mr. G. W. Stow, Dr. Rubidge, Mr. James Wyatt, Mr. C. C. Blake, Mr. J. Yates, Mr. Seeley, Mr. Plant, Mr. Sorby, Mr. T. Rupert Jones, Professor Ramsay, and Mrs. Acworth, my special thanks are due, and to many others I would wish to make personal acknowledgment if space allowed.

The space devoted to correspondence gives a means of freely discussing any important topic without rendering the Editor, or the Magazine, responsible for the opinions expressed. The beneficial influences of the free scope thus given to the expression of opinion must already have become evident to all, and the advantages of some of the other changes made in the arrangement of the Magazine must likewise be apparent.

Notwithstanding the necessity of increasing the price in order to ensure the permanent commercial stability of the journal, our circulation has materially increased—a satisfactory and convincing proof of the increased usefulness of the work, and the friendship of the geological public towards it.

From Sir Roderick Murchison, Sir Charles Lyell, and other eminent geologists, I have received flattering encouragement; and it is much to be able to say that men of such eminence regard with interest the success of this publication as a valuable medium of communication, and as an important means for the accumulation of new facts.

The arrangements made for the forthcoming year, while they in no way diminish my personal interest in the Magazine, will provide against those unavoidable impediments which ill-health and ever-increasing professional engagements put in the way of my individual attention to the details of publication.

For the future, however, we will make no promises at all; but we hope ever to be judged by results attained.

S. J. MACKIE.

London, 1st December, 1861.

THE GEOLOGIST.

JANUARY, 1861.

HIGH AND LOW LIFE.

By George E. Roberts.

Our knowledge of the limits of animal life have been notably extended during the year which has just departed. Air, blown upon an adhesive surface by the aeroscope on the summit of Etna, twelve thousand feet above the sea level, has been found to contain large quantities of Diatomaceæ; and thus the presence of a zone of life has been discovered to us, soaring not only above the limits hitherto fixed, but above the range of physical phenomena in the mountain itself.

And now the ocean-depths have given up a secret as marvellous. We are taught that at a depth below the surface nearly as great as the height of the infusorial zone above it, animals as high in the scale of being as starfishes are enjoying life. The one discovery is a fitting pendant to the other, and yet, how great is their difference! In the one case the extreme rarification of the atmosphere seemed to our notions to render life impossible; in the other, the enormous pressure of the opposite element, which in the homes of these starfishes must amount to at least a ton and a-half on the square inch, is so greatly at variance with our belief, that we are confounded at the very outset of the inquiry. The capability in an animal so well accustomed to air as the starfish—whose ordinary domain is the sea-beach—to exist without it, and its inherent power of withstanding a pressure that would upon the surface grind a rock to powder, are studies replete with instruction and value—studies which can be turned to a good geological account, and made to bear reference to a past fauna as well as to a living one. I will attempt, therefore, to give an abstract of the valuable contribution to our knowledge of animal life in deep sea-zones, which contains the important discovery I allude to;* for as the pamphlet is printed "for private circulation," it is only attainable by the few. In it the author not only gives us in one view a *résumé* of our present data upon the subject, but a series of notes which point, with no uncertain finger, to a great extension of them.

Dr. Wallich's zoological labours while on duty entitle him to rank as no mean associate of the great naturalists to whom he gracefully dedicates his notes; and the modest way in which he introduces a strong foundation for a most important inquiry, proves that he looks upon scientific experience

> "As an arch wherethro'
> Gleams that untravell'd world, whose margin fades
> For ever and for ever when I move."

In sounding not quite midway between Cape Farewell and Rockall, at a point east of Iceland, and in one thousand two hundred and sixty fathoms of water, the sounding apparatus brought up an ample specimen of coarse gritty-looking ooze, containing about ninety-five per cent. of *Globigerina*-shells (an important genus of the Foraminifera); while adherent to the lowest fifty fathoms of the line, a number of starfishes, belonging to the genus *Ophiocoma*, came up. They had attached themselves while this part of the line, which had been paid out in excess of the depth, rested upon the bottom, not at all calculating what an upward journey their investigations would cost them, and what a greeting they would receive. They continued to move freely about for a quarter of an hour after their introduction into human society, and from the naturalist and his wondering

* "Notes on the Presence of Animal Life at Vast Depths in the Sea; with Observations on the Nature of the Sea-bed as bearing on Submarine Telegraphy." By G. C. Wallich, M.D., F.L.S., &c.; naturalist to the expedition despatched in 1860, under the command of Sir Leopold M'Clintock, to survey the proposed North Atlantic telegraph route between Great Britain and America. 1860.

friends the illustrious strangers received every courtesy and attention. But, as may be supposed, they were too precious to be returned to the deep-sea home they had left, even supposing they could have got there; so were put in spirits, and consigned to an immortality they little expected. One fine fellow, who clung convulsively to the rope, was secured *in situ*, and is now a "lion" of scientific London.

"Here, then," says our author, "is a fresh starting-point in the natural history of the sea. At a depth of nearly two miles below the surface, where it is difficult to believe the most attenuated ray of light can penetrate, we find a highly organized species of radiate animal living, and evidently flourishing; its red and light-pink-coloured tints as clear and brilliant as those seen in its congeners who live where the sun's rays can penetrate freely. Differing in no respect of internal anatomy from the species of *Ophiocomæ* inhabiting shallow water, and evidencing, by their freedom of life and action, that circulation of sea-water, digestion, assimilation, and reproduction were carried on in their frames, unrestricted by the obstacles enumerated, in addition to the simpler but no less essential operations of locomotion and capture of food." In the alimentary cavity numerous *Globigerina*-shells were found, more or less freed from their soft sarcodal contents.

Now the Ophiuridæ, to which division of star-fishes *Ophiocoma* belongs, differ from what are usually called true star-fishes of the well-known stellate or angular forms, by the absence of protrusile suckers as organs for effecting motion ; the want being in them supplied by spine-covered arms, from which they derive the name of "spinigrada." They have no power whatever of raising themselves from the bottom, or of travelling in other fashion than as creeping, crawling animals. Moreover, Professor E. Forbes has told us in his "Monograph on the British Starfishes," that the Ophiuridæ is a more local family than starfishes proper, and more affected by climatal causes. So that, though the discovery of any starfish under the circumstances is wonderful enough, the marvel is increased tenfold by its being a Spinigrade form ; for as the point of capture was five hundred miles from Greenland, and two hundred and fifty from Iceland—Cape Farewell in the former, and the "Blinde Skier" rocks in the latter being respectively the nearest land—it is impossible they could have been a chance drift, borne along by a current from either country. "Therefore," says Dr. Wallich, "all former opinion as to the limit of life in the deep sea must give place to such a startling fact. And where one form so highly organised has been met with, it is only reasonable to assume that other correlated forms may also exist: and we may look forward to the discovery, at no very distant period, of a new submarine fauna, frequenting the deeper fastnesses of the ocean, which, while furnishing a new field of research for those who are content to seek after living novelties, shall also throw a gleam of light on the geology and palæontology of the globe."

Respecting the *Globigerina*, those minute Foraminifera whose shells constitute so large a proportion of the "oozy" deposits brought up by mid-Atlantic soundings, one interesting subject of debate has been set at rest by Dr. Wallich's discoveries. They *do* exist in a living state at great depths, though the signs of life apparent in them when examined after an hour's upward travel from the sea-bottom to the surface, were feebler than in those taken from beneath shallow water. Indeed, irrespective of the experiments by which the author arrived at this conclusion, the circumstances of their having been detected in the digestive cavity of one of the starfishes makes it highly probable that they form their chief source of food.

In several samples of *Globigerina* ooze, the minute cell-like bodies provisionally called "Coccoliths" by Prof. Huxley were detected, looking at first sight very like the cells of the algal plant Protococcus (now shown to be an abnormal development of lichen-gonidia); those Dr. Wallich considers may probably be the larvæ of the *Globigerinæ*. They appeared in two states, as globules adherent to the surface of cellular mycelia, and as free moving bodies, showing in some instances the commencement of cell-division. Their discovery in a living state in this oose is of high geological importance; for microscopical investigation, undertaken by Mr. Sorby, proves their existence in chalk-rocks, associated there, as they are in this North Atlantic ocean, with *Globigerinæ*. Indeed, chalk itself is seen to be little else than a compacted mass of Foraminifera shells, whole and fragmentary, and may be best described by using the very words by which Dr. Wallich introduces to science the recent deposit. Light from discoveries of to-day is thus thrown backward, and thus finds reflection in analogous conditions of deep-sea deposits and buried animal-life at a remote geological period, which in turn aids us in investigating present life, and proves that conditions favourable to Foraminifera-life could support Radiata, Echinodermata, and Mollusca, which, could we dredge as well as sound in the deep Atlantic, would doubtless reward our search.

As yet, no companions to the *Ophiocomæ* and *Globigerinæ* have been taken from the enormous depth at which these forms of life exist, but a living *Serpula* was obtained from a sounding of six hundred and eighty fathoms, in conjunction with a living *Spirorbis*. Other free Annelids, and two amphipod Crustaceans, were also taken alive at four hundred and forty-five fathoms; depths, be it remembered, far beyond any previously-known habitat.

Some remarkable phenomena connected with atmospheric influences are noticed by Dr. Wallich during his cruise, such as the almost entire absence of those varied forms of animal life which usually present themselves upon the surface, such as Pteropods. This he attributes to the severity of the past season, which appeared to have exercised such an influence upon surface-water life, that even Diatomaceæ were scantily represented. And another matter worthy of note was the scarcity of drift-timber, in ordinary years borne along by the deflection of the Gulf-stream, and cast upon the coast of Greenland. This our learned author advisedly regards as a proof of a variation in the course of the Gulf-stream proper, before it was caught up and deflected by the Arctic current; or, what is still more probable, that this year has been marked by an extension of the Arctic current, sufficiently great to overpower and deflect the Gulf-stream, bear down its floating burden to other lands, and materially lower the temperature of Northern Europe.

Some sensible hints as to the surveying of the sea-bottom beneath deep water are given by our author; and he suggests, with a kindly feeling towards further investigators, a sensible method of procuring Diatomaceæ, Polycystineæ, &c., from sea-water, which being quite new, and likely to turn many good things into the hands of those who study these tiny but most important organisms, I am glad to include in my abstract. When the boilers of steam-ships are being cleaned, procure portions of the calcareous deposits scaled off the interior, and by treating them in the usual way with nitro-muriatic acid, *Diatomacean*-forms and *Polycystina*-shells may be detected in considerable quantity.

By obtaining these deposits from ships plying within known limits, a series of free floating *Diatomaceæ* might be secured which would afford good data for the ascertainment of their range, distribution, and limits. And so, heartily thanking Dr. Wallich for this crumb of friendly feeling, I close his pamphlet. The year that has just departed has thrown no light of equal importance on geological history; though it has been a very notable year in geological science—notable in the importance of its discoveries, thoughtfully made, and carefully introduced; and beyond measure notable in its crop of theories, and in the agitations produced by them. But of these latter "helps to knowledge" we have surely had enough. Dr. Wallich has sent the ball rolling in another direction; and his labours are more clearly reflected in the mirror of Truth than is any attempt to claim creative power for the working of secondary principles.

A CHRISTMAS LECTURE ON "COAL"

By J. W. Salter, F.G.S.

Not a great many years ago the "bigwigs" in England were assembled in conclave, and the *élite* of science was called before them. There were a great many lumps of a blackish-brown substance on the table, and a great deal of smelling, and burning, and poking of the same black lumps by the same "bigwigs" and learned men. It was the great "Torbane Hill Coal" case.

> "The point was in question, as all the world knows,
> To what the said substances ought to belong."

Was it pure carbon? Was it carbonaceous shale? Was it shale without much carbon? Was it carbon without much shale? Was it bituminous shale? Was it coal-shale? Was it cannel? Was it coal?

We are afraid to say how many guineas were spent, or how many microscopes were busy in London and Edinburgh. But after all the question was simply this, "What is coal?" We are not going to try to give a definition; but if we can show our young readers (and there are, we hope, a good many of them) a few of the facts connected with the structure, contents, mode of formation, &c., of a coal-field, perhaps we may be able to answer the formidable query, "What is coal?" without calling in the aid of counsel, and our fee is—one shilling. As this is a Christmas lecture for our young friends, we hope our senior readers will not take it amiss if elementary phrases are introduced, and a few woodcuts given to illustrate what they know very well.* And perhaps we may be allowed to speak in the first person singular; it is more conversational.

First, then, where is coal found, and how? Of course we all know it is a mineral substance, bedded deep in the bowels of Old Mother Earth. And I need not tell most of you that Old England has more of it than any other European nation; that she is much dependent on it for all her industry; that it has helped to make her peaceful conquests over half the world. And some of you may perhaps know that she is now so tired of using it in this way, that she is going to make a present of one-half of it to her dear friend France—for purposes of war!

A glance at some of the places celebrated for coal will perhaps be the best way to learn the mode of its occurrence. Let us take for instance a place where they send our best coals *from*, but where *it is no use to send coals to*. The Newcastle district is perhaps, all things considered, the richest in England. The river Tyne, rising, as many decent rivers do, in the pure air of the Cheviots, waters all the central parts of Northumberland, and enters the sea at Tynemouth, with far less unsullied purity than it left the mountains with. It is saying much for the traffic on its banks, that the Tyne is nearly as black as the Thames before it reaches the sea. This traffic is wholly in coal.

The Tyne cuts its way through the very heart of the coal-field; the flourishing towns of Hexham, Gateshead, and Newcastle being some of those which dot its banks, while Tynemouth and Shields are the grand ports for its black produce. Get out your map of England if you please, as we shall have further occasion to refer to it. And now I think of it, the little map, coloured by Sir Roderick Murchison, and published by the Society for the Diffusion of Useful Knowledge, is the best we can have, for it has both map and geology all in one.†

Well, we are on the banks of Tyne, looking at the never-ending chimneys and coal-engines. The river is full of collier-brigs; and at the ports there are the long high jetties for embarking coal, and the blazing coke-heaps on the wharves, for the black diamond is not only life but light to Newcastle.

* And it must be understood that we are not going over again the same ground which Prof. Buckman took in the first volume of this work. He was showing us how to search for coal, *this* is for those who know very little about it.

† Stanford's, Charing Cross. Price 5s.

Last, not least, there are the iron furnaces; for in England, happy England, coal is always found in company with iron—the objects of industry with the means of employing industry; the material, and wherewith to work it up; two of the great civilizers of mankind hand in hand. Coal cannot live without iron, and assuredly iron cannot get on without coal.

I will now just sketch the outlines of this coal-field, and you can follow me on the map. You see it is of a long shape, skirting the sea-board from a point a little south of Alnwick, and, passing by Morpeth, it swells out to its greatest width on the Tyne; then crosses the Derwentwater, runs past Durham and Bishops Auckland, till it reaches the Tees, not so very far from Barnard Castle and Rokeby. Here it sweeps round to the east, and gives that classic region a wide berth. Scott would never have thought of laying the scene of Rokeby among barges and chimneys; and I doubt whether Bertram would have proposed to swim the Tees, had it been choked with coal-dust. The loves of Redmond and Matilda, too—well, let that pass.

From Shields southward you will perceive that the coal-field does not actually reach the sea. There is a narrow strip of Magnesian Limestone runs all along the sea border, and the most familiar coal-ports, Monkwearmouth, Sunderland, Hartlepool, are not *on* the coal. However, Walls End, from which in our simplicity we think all our coals come, is actually on the coal. I have been told, however, that there is sometimes more Walls End (that is, brick-bats) in my coal-cellar than I had ever supposed.

I do not know if the number of coal-pits in this magnificent field is accurately estimated. They employed over forty thousand men some years back. The deepest pits are where you might expect them—about the middle of the coal-basin, north of Durham. Some of these are of great depth indeed; one thousand six hundred or one thousand eight hundred feet does not look very much on paper, but if we try to measure it by means of the highest buildings we are acquainted with, we shall understand its enormous depth better. In the north part of the field, three hundred to five hundred feet is nearer the mark.

I shall here recommend to anyone who wants to know more about coal and coal-pits than we can tell them in this short lecture to buy a little work by the Rev. F. Leifchild, called "Our Coals and Coal Pits." I suppose there are very few persons who might not profit by it, and few young ones who would not be merry over it. It may have some errors; what work has not? but it is full of useful and pleasantly told information.

And now, that we may understand clearly what a coal-field is, we must give a sketch of a coal-basin, such as is usually found in Britain. You may turn back to vol. i., p. 188, to see another section by Prof. Buckman: his will not, however, do for our purpose, and we shall refer to the one on the opposite page now and again.

If we were to walk along the banks of the Tyne, however, we should only see about half the basin, as far as *g* for instance; the remainder is hid beneath the sea. But even that half will show the beds in the same order or succession. The Mountain Limestone is a fine rock, and forms most of the high moory ground on the west. Many a border skirmish has been fought upon the heather that

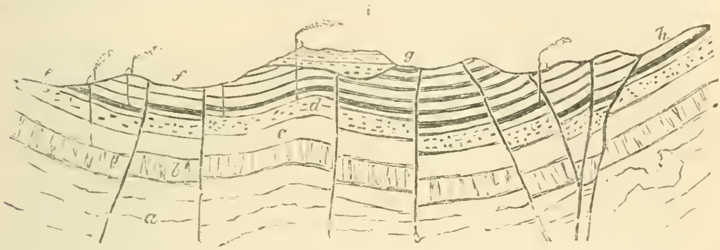


Fig. 1.—Ideal Section of a Coal Basin, to show the usual arrangement of the Beds, and the Dislocations caused by Faults.

a, Old Red Sandstone; *b*, Carboniferous or Mountain Limestone; *c*, Millstone Grit; *d*, Farewell Rock, sandstone chiefly: *e*, *f*, *g*, *h*, coal seams, or beds, the layers of coal from one foot to ten feet thick, and with shafts piercing two, three, or more of the beds, as the case may be; *i*, Magnesian Limestone and Red Sandstone, unconformable on the Coal-beds.

covers its surface; and many a bold moss-trooper has ridden for dear life across the bogs that ornament this formation,* and the one succeeding, viz., Millstone Grit.

It should be noticed that the "Millstone Grit" is all or nearly all sandstone—sometimes clayey, but more often hard; and the lower part of the coal-formation itself is nearly all sandstone, with a few bands of clay or shale. But as we rise higher in the beds, the clay grows more and more, the sandstone still being present in large quantity, till shale, as it is called, often makes up the chief part of the beds. Under every seam of coal, with scarcely an exception, lies a bed of what is called fire-clay, a rather hard clay, which makes excellent linings for stoves and furnaces, and which besides is used for crucibles and other purposes. Of this clay more by-and-bye, when we come to speak of how coal is formed.

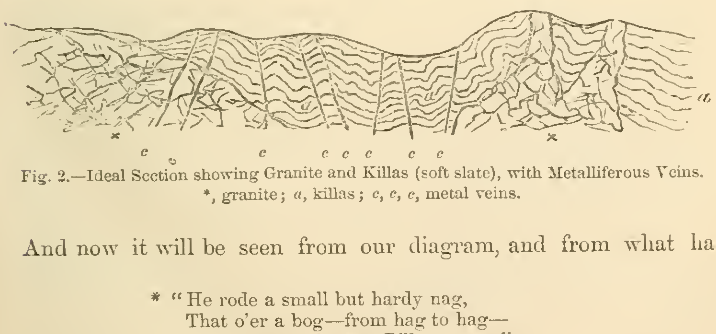


Fig. 2.—Ideal Section showing Granite and Killas (soft slate), with Metalliferous Veins.
*, granite; *a*, killas; *c*, *c*, *c*, metal veins.

And now it will be seen from our diagram, and from what has

* "He rode a small but hardy nag,
That o'er a bog—from hag to hag—
Could bound like any Bilhope stag."

been said, that coal is always found in layers and beds, not in veins, as metals are. If you compare the following sketch of a mining country with the coal-field above given, you will see the difference at once. This difference is of the greatest importance in mining for coal, as we shall see by-and-bye, but we must not wander from our point at present.

I have only run over one of the coal-fields of Britain yet, and not quite the largest. There is the Whitehaven coal-field, which supplies all Lancashire, and which has galleries far beneath the sea. The great Yorkshire coal-field is one of our busiest manufacturing districts. We may well say that, when we remember that Bradford, Leeds, and Halifax are the very heart of the cloth trade. This important field runs down in a long strip to Nottinghamshire, passing by Doncaster and Mansfield. It includes nearly one thousand square miles, and it is really larger than this, for they have been trying of late to find coal beneath the Magnesian Limestone to the east of it. The Duke of Newcastle has lately sunk shafts, and profitably too, through the limestone and the red rock beneath, and then pierced the coal, and got plenty of it.

Now the Yorkshire coal-field runs down (see the map) all the eastern side of Derbyshire, outside the Mountain Limestone of that beautiful tract. On its west side runs the Lancashire coal before-mentioned. Thus both sweep round the limestone like a mourning cloak thrown over the shoulders; and here again we see the close connection of Mountain Limestone, Millstone Grit, and Coal.

The little tract called the South Staffordshire coal-field is a rich, nay, for the size the richest of all our coal-fields. Except one in Nova Scotia, this little coal-field contains the very thickest seam of the invaluable mineral known in the whole world, for the "Thick Coal" of Staffordshire is thirty feet. And I believe more iron, is got here than in any other district of the same area. The Dudley and Wolverhampton ironmasters are the princes of the trade, though South Wales is treading closely on their heels. I need only mention that five million tons are raised per annum in this district — worth a million and a quarter pounds sterling.

There are the smaller fields of Ashby de la Zouch; the Tamworth coal-field, with its beds thrown up in nearly a vertical position; the Bewdley or Forest of Wyre; Shrewsbury; Lee Botwood; Clee Hills; all little patches, which once no doubt were joined together. But the restless sea swept over them, and since they have been raised into dry land, the breakers have beaten against their coasts till they have left us only shreds and patches of what was once a continuous coal-field in mid England.

Then there is the Flint coal-field, which keeps the North Welshmen warm. It ranges from the sea near Chester to Oswestry, on the borders of Shropshire, and, in conjunction with the lead-works in the limestone (Mountain Limestone again you perceive) which, runs all the way along its edge, keeps a large population busy. It does one's heart good, when going into Wales for a holiday (and you are always kept waiting at the Llangollen Road Station), to turn for a while and look over this busy coal-field perched high on its limestone terrace. Don't give all your attention to the mountains, but think of the labour that is going on around you, amid those hundred chimneys and in that dingy atmosphere; and reflect, too that the picturesque scenery on your left is, like much else that is beautiful, only for holiday wear, while the hard work on your right is the true condition of our life if we would attain the useful.

Then if we take the train to Bristol, we shall find another small but productive coal-field, thoroughly well worked, and for its area very rich. It has been computed to contain six thousand millions of tons. If they could only get it all! It supplies one and a-quarter millions annually. Across the Severn is the Forest of Dean, an oval mass of high ground, rich in coal and iron. It was one of the earliest places where iron was worked; and the old rude furnaces are still occasionally discovered. There are twenty to thirty seams of coal here; and if you want to see what a coal-field really is, on a small scale, look at the model by Sopwith of this district. It is in the Museum of Practical Geology, Jermyn-street; and you may know more about a coal-field in an hour by consulting it than by reading this lecture for double the time.

Now we are near the great South Wales coal-field, or coal-basin, as it is better called; a mighty mountain mass that runs for seventy miles from Monmouth to Pembroke. Across its width, from Swansea to Merthyr, it measures full twenty-five miles. Its area is computed at one thousand nine hundred and forty-five square miles, and its production is enormous. Nearly all our steam-coals come from thence; and there it is that those wonderful furnace-coals, called anthracite, are found. If you draw a line across the field from north to south—from Swansea to Merthyr—you will find that all on the west side is anthracite, or stone-coal, and all on the east bituminous, or caking coal*—very nearly so. There are, of course, some exceptions to this remarkable rule, for which I really can give you no good reason. It is supposed that deep-seated volcanic matter has acted on the western half; but we see no trace on the surface of this. The fact is certain, nevertheless, and a very curious fact it is. Those who have had occasion to travel along the network of railways which run among these hills will know that the coal crops out, as it is termed (that is, shows itself), along the sides of the hill in seams. It does not hide itself here in deep underground workings, but is sometimes even wrought out in the face of day as a quarry, more often obtained by levels into the heart of the mountain, in the way they work for metals And they have such abundance of water-power, that when compelled to raise coal from greater depths, they can often employ what are called lifts, or balances (cisterns which are alternately filled with water or coal), and so make the water itself lift the coal out.

* For an excellent short description of this field by Dr. G. P. Bevan, the reader may turn to vol. i. of this work. p. 126, &c.

Add to all these natural advantages a very large supply of coal important for Government use, some very intelligent masters and overseers, cheap labour, and easy access along the valleys* to the ports, and you will not wonder that South Wales should be prosperous. There is an Institute for Engineers specially for this coal-field; and he must be a second-rate man who cannot realize his £800 or £1,000 a-year at least by the charge of a set of works. Many of the owners are extremely wealthy, and hospitable too. And somewhere on the northern crop I visited a friend, who is at once magistrate of his district, lieutenant of a rifle corps, surgeon of a large work, organist, lecturer, a good geologist, and a kind man.

The north and south borders are called respectively the north and south crops. Along the northern edge the strata lie pretty flat, or gently inclined. They rest upon the terrace of Millstone Grit and the Mountain Limestone precipices overhanging the red sandstone country of Crickhowel and Abergavenny.

On the southern crop the beds of rock lie at a steep angle, and again from beneath them come out the Millstone Grit and Mountain Limestone of Oxwich and the Mumbles; or, further west, the great limestone cliffs of Tenby, which of all places is *the* place to study Mountain Limestone, Old Red Sandstone, and contorted coal-strata.

There is one more coal-field in Britain, but a poor one, the culm-measures of Devon, only worked for local use; and it is more than probable that these culms are coal-beds in the Millstone Grit series. For in Scotland, of which we have not yet said anything, and where the richest seams are found, not only in their proper beds, *above* the Millstone Grit, but *in* it and all *through* it. Nay, it does not stop here, for in the Lothians and Fifeshire, as indeed is the case in Northumberland, there are coals and coal-shale among the beds of Mountain Limestone, thin layers of this black fuel lying under mountain masses of the limestone rock; and here and there are coal sandstones, rippled and worm-marked, showing the action of large lakes, or, much more probably, of the tides on the surface only just before occupied by a coal forest.

Nor is this all, for deeper still, and far below the Mountain Limestone, the Scotch coal-beds lie in the Lower Carboniferous strata. The celebrated Burdie House beds of coal and limestone are among these.

The great quarries of coal sandstone around Edinburgh, from which their fine building stones have been quarried, lie far below the lowest level of the Mountain Limestone. There is a charming little work—the "Story of a Boulder," told by Archibald Geikie, that gives a clear notion of the Scottish coal-fields in most pleasant and readable style.

And then for Ireland. We might almost write a chapter on the coal of Ireland as short as Swammerdam's famous chapter "On the Rats of Africa"—"There are no rats in Africa," said the naturalist; and it is all but the same in Ireland. True, there is a patch or two

* The Crumlin Viaduct in Taff Vale is a splendid work of art.

at Dungannon, and in Clare and Kilkenny; but the beds are so poor in coal, and the produce altogether is so very small. It would almost seem as if Providence had made amends for the scanty supply, and indicated the direction Ireland's industry should take, by covering her fertile limestone plains with the exhaustless peat. Peat is the Irishman's friend, and like the seal to the Greenlander, supplies him with light, warmth, and even building-materials; and now they are manufacturing peat, it will be meat and drink to the Irish peasant.

We have seen *how* coal is found, and *where* in Britain; how it lies there in beds or basins, not in veins or bunches; how it occurs mainly in the great Palæozoic formation, above or about the geologic place of the Mountain Limestone. And this is true for nearly all of Europe, and of the mighty coal-fields of America. But it is not the case over the whole world. Even in our own country there are coal-beds in our oolite rocks, above even the New Red Sandstone; and in Yorkshire these rocks are neither few nor barren.

This "oolitic" coal is the common coal of Virginia, in the United States. A similar coal forms our staple supply in the East Indies. We have oolitic coal at Natal and along a great part of southern Africa. Australia is supplied with oolitic coal. Wherever Englishmen found a colony, there is coal; but it is not all of the same age. Borneo is not yet ours, but there is coal.

And there is tertiary coal. Our own little coal-field at Bovey Tracey, Devonshire, is a miniature representative of much larger brown-coal fields in Germany. The Miocene coal of the Rhine is little better than a fossil peat;—sticks, and leaves, and fruits, and here and there an insect, a fish, a frog, are found in this freshwater coal. If a fox got drowned in these old swamps, he, too, turns up as coal for German firesides. Nothing comes amiss. Some varieties of this tertiary coal are little else than pond confervæ matted close together, and layers of such like peaty matter form the dysoile, or "paper coal."

So there is every transition in mineral composition from the peat bog to the coal-bed; and it is not anticipating our next lecture to say that all coal, of whatever kind or value, is vegetable produce. It would be out of place to doubt that our youngest readers know this fact; what we propose to do next time is to give a short account of the methods of extracting these precious black diamonds: to show what kinds of vegetables produced our great coal-fields; and to discuss briefly the valuable services we receive from "Coal."

(To be continued.)

RESEARCHES ON PSEUDOMORPHS.

By M. Delesse.

Translated from the "Annales des Mines"* by H. C. Salmon, F.G.S.

(*Continued from page* 453, *vol.* iii.)

Pseudomorphism.

When a mineral presents itself under a form which does not belong to it, there is then what I shall call *pseudomorphism*.

The substance from which the mineral borrows its form may be of any kind—inorganic or even organic. It is called original or *pseudomorphosed*, while the mineral which replaces it is called *pseudomorphic*.

Pseudomorphism by *alteration* is that in which the pseudomorphic mineral still contains the elements of the original substance. Pseudomorphism by *displacement* is that in which this is not the case. In order to understand the difference which exists between these two kinds of pseudomorphisms, it suffices to mention as examples iron-pyrites, which changes into limonite, still preserving its crystalline form; or fluor, which after being completely destroyed, is replaced by quartz. The name of *paramorphism* has been given to the kind of pseudomorphism which is produced without modification of chemical composition. Arragonite changed into calcite, and pyrite changed into marcasite are examples.

At first sight it seems that these metamorphoses of minerals must be very exceptional, but observation teaches us, on the contrary, that they are met with in a number of localities; they are, moreover, extremely varied. In fact, they include all the alterations to which minerals are subject in their structure and in their chemical composition. They include also, as a particular case, the decomposition of minerals; and kaolin, for example, results from a true pseudomorphism of felspar.

When organic bodies, whether animal or vegetable, are pseudomorphosed, there is produced what M. Naumann has called zoomorphs and phytomorphs.† The pseudomorphism of organic bodies may likewise be established as easily as that of the best crystallized mineral; for, although the form of these bodies may not be simple and geometrical, it is, however, quite characteristic, and moreover it corresponds to a known composition. Besides, the study of this pseudomorphism is not less interesting than that of minerals, and it takes place by the same processes. The comparison of the original

* Vol. xvi., p. 401, 6th livraison: 1859.

† C. F. Naumann "Elemente der Mineralogie."

substance, organic or inorganic, with the mineral which has replaced it, permits us immediately to recognize and understand its metamorphism; moreover, as the minerals and organic bodies have a generally constant form and composition, their metamorphism may be much more accurately defined than that of rocks.

The principal researches in pseudomorphism are due to Werner, Haüy, Mohs, Langrebe, Freiesleben, Blum, Breithaupt, Haidinger, Mitscherlisch, Sillem, C. F. Naumann, G. Bishof, G. Rose, Hausmann, Dana, Phillips, Kenngott, Scheerer, Rammelsberg, Plattner, Reuss, Hermann and Antoine Müller, Léonhard, Zippe, Quenstedt, Glöcker, Von Dechen, Suckow, Nöggerath, W. Stein, Fœtterle, Scacchi, Delafosse, Descloizeaux, Roth, Wiser, Von Zepharovich, Nauck, Tamnaw, De Carnall, C. Von Haüer, Foster, Whitney, Jackson, Fowler, Websky, G. Brush, Smith, Shepard, Bronn, Vinkler, Volger, Hessel, Oppe, Fr. Sandberger, Dieffenbach, Schüler, Credner, Gutberlet, Dauber, Beck, Carius, Greg, W. G. Lettsom, Fox, Söchting, Veibye, Forchhammer, Von Rath, Kjerulf, Von Richthofen, Gergens, Richter, Girard, Jensch, Heffter.*

Difficulties of distinguishing between Envelopment and Pseudomorphism.—Before summing up the observed facts, it seems to me necessary to call special attention to certain deceptive appearances in pseudomorphism.

In the first place, when two minerals envelope each other, if the enveloped mineral is completely destroyed and has disappeared, the enveloping mineral may easily retain its form; there is then produced a special metamorphism which arises from an incrustation, and which is visibly connected, in the most intimate manner, with envelopment. Now it sometimes happens that one mineral is surrounded by another which results from its alteration, which is especially what we observe in anhydrite and gypsum. Certain mineralogists have conversely presumed from this, that when two minerals envelope each other, the one results from the pseudomorphism of the other. This may certainly be the case sometimes, but we may soon easily discover that it is not what occurs most usually.

Moreover, when a mineral is crystallized, it frequently envelopes a very notable proportion of another mineral. The dominant mineral is not even that which gives to the mineral its crystalline form; and generally it has been considered as pseudomorphic. Is there here, then, an envelopment; or, on the contrary, pseudomorphism? The solution of this question presents, as we shall see, very great difficul-

* The publications relative to pseudomorphism have been so multiplied of late years, that it was necessary to renounce giving a list of them here. They are to be found specially in the various publications of Germany, particularly the "Neues Jahrbuch" of Leonhard and Bronn; "Jahresbricht" of J. Liebig, Hermann Kopp, and Will; "Zeitschrift der Deutschen Geologischen Gesellschaft;" "Poggendorf Annalen;" &c. Besides, they have been summed up in the classical works of R. Blum, C. F. Naumann, Haidinger, G. Bischof, Dana, Kenngott, &c.

ties; and in order to solve them we must, in the first place, seek to ascertain how envelopment is produced.

When a mineral crystallizes, the substance which it envelopes remains sometimes amorphous. This, for example, is what takes place in the sand which is found in the rhombohedrons of calcite from Fontainebleau. It is the same with mâcle, (andalusite,) which, according to M. Durocher, has retained a part of the schist in the midst of which it formed. But the mineral enveloped in another which is crystallized, has most frequently been crystallised itself. If we consider two minerals in those conditions, we must distinguish the case in which their crystals are independent, and that in which they are symmetrically arranged.

1st, *Envelopment without Symmetrical Arrangement.*—The first case is the simplest and also the most frequent. Generally, when two crystallized minerals envelope each other, their crystals have any direction with regard to one another, and are independent.

Thus magnetite in hornblende, chlorite in calcite, mica in augite, in hornblende, in orthoclase, and in the felspars, are most frequently in crystals completely independent of the minerals in which they have formed themselves.

As long as the enveloped mineral is found in crystals clearly isolated and not numerous, no confusion is possible between envelopment and pseudomorphism. On the contrary, we find ourselves in the presence of the greatest difficulties as soon as the enveloped mineral becomes sufficiently abundant to disguise, as it were, the enveloping mineral; or when it is associated with it so intimately that the one passes insensibly into the other. For example, garnet has been considered pseudomorphic after idocrase because it is observed sometimes in its interior; and this is, indeed, what I had the opportunity of verifying in the collection of M. Wizer, at Zurich. But it is necessary to remark that the idocrase is, in its turn, enveloped by the garnet. Although it is very easy to conceive the metamorphism of these two minerals, since they have nearly the same chemical composition, I think we should only admit it if it were clearly established that the garnet can substitute itself entirely in the place of the idocrase.

We should also observe the same reserve with regard to iolite, (dichroit, cordierite,) and mica; for iolite, whenever it bears no trace of alteration, often covers itself with very numerous scales of mica, under which it so disappears, that it is necessary, in order to recognize it, to examine its fracture in a plane perpendicular to the scales. In the variety of Amity (Maine) which has been designated under the name of chlorophyllite it is easy to establish that the large scales of green mica are very close together, and that they alternate with the bluish white.

Is it quite certain that mica pseudomorphoses kyanite (disthene)? I do not think so; it has merely seemed to me that kyanite frequently enveloped a greater or less proportion of mica, which was mixed with it, and into which it might even pass. But there is nothing in this circumstance which should surprise us, for kyanite is found especially in rocks which are very rich in mica: moreover, the mica which penetrates it is completely identical with that of the mica-schist in which it is formed. It is, therefore, very plain that the mica and the kyanite were crystallized simultaneously, and at the same time as the rock which incloses them.

The same remark applies to andalusite, to chiastolite, to staurolite, to hornblende, to augite, &c., which are often more or less penetrated by the micas. In the very numerous specimens I have examined, the various minerals were not pseudomorphosed; they simply enveloped the micas, which were identical with those of the rocks in which they were formed.

The largely lamellar chlorite, which in chlorite-schist envelopes and penetrates, often in the most intimate manner, crystals of magnetite, and which does not differ from that which constitutes the chloritic schist itself, does not seem to me to result any the more from a pseudomorphism.

I am inclined to believe that it will be necessary to make pretty numerous suppressions among the minerals which are regarded as pseudomorphic, and particularly among the silicates. The only pseudomorphic which should be retained are those which take the form of another, and which are, besides, susceptible of replacing it completely. It is, moreover, easy to understand that when minerals have crystallized simultaneously, they were in a position to associate and envelope themselves in easy proportion; which, indeed, before long will become still more evident.

2*nd*, *Envelopment with Symmetrical Arrangement.*—Envelopment is sometimes accompanied by symmetrical arrangement, and then it is necessary again to distinguish many cases.

Symmetrical arrangement is observed, in its rudimentary state, whenever the two minerals are grouped in respect to each other with a certain symmetry. This, for example, is what seems to occur in the galena of Neudorf, in the Harz, which forms a thick and more or less regular crust around calcite. According to Messrs. Scheerer and Blum, this galena is in very brilliant crystals, which attain the size of a nut, and present combinations of the octohedron, the cube, and the rhomboidal dodecahedron. It envelopes the calcite, and is also enveloped by it. Its thickness is often reduced to that of a sheet of paper.

Garnet offers the same peculiarities at Arendal, at La Bergstrasse, and at Le Canigou: for its crystals envelope calcite which is likewise crystallized, and the thickness of their sides may become microscopic. Sometimes also a crystal of garnet envelopes pistacio-green epidote (pistazite), which in its turn envelopes the calcite. Moreover, garnet may similarly envelope felspar, quartz, hornblende, diallage, gypsum, &c.

The idocrase of Christiansand, which has formed in the saccarhoid limestone, is in large crystals, which have only a few lines of thickness, and which also envelope the calcite.

Philogophite mica occurs in reddish-brown laminæ, which invests in a very remarkable manner the augite of Monroe, and which are disposed almost perpendicularly to its faces.

The mica which is formed in hornblende, augite, iolite, pinite, chlorophyllite, presents sometimes a determined direction, and its laminæ are parallel.

The felspar of the syenite of Norway, as we have seen, envelopes natrolite, which in its turn envelopes a kernel of this same felspar. Fluor envelopes pyrite concentrically.

Symmetrical relations may again be well observed in macle* (andalusite), which has symmetrically grouped the schist which it envelopes. It appears also in certain crystals of hyalin quartz, which contain small grains of quartz, which are crystalline and very distinct; these latter are grouped parallel to the faces, either of the regular hexagonal prism, or of the pyramid which surmounts it. This, for example, M. Des Cloizeaux has observed in the quartz of Brazil. He has also shown that Iceland spar contains isolated grains of calcite, which are generally grouped parallel to the faces of the metastatic or to those of the primitive rhombohedron. When pyrite is disseminated in microscopic grains in spathic carbonate of lime, it also groups itself, following the same plane; and it is the same with the chlorite (ripidolite) which is enveloped by the dolomite of Traverselle.

But the symmetrical arrangement may be still better characterized than in the preceding examples; and then it occurs at once in the two minerals, either by relation to a centre, or by relation to axes, according as one or the other case occurs; it is hence central or axial.

Central Symmetrical Arrangement.—Metalliferous lodes sometimes show a well marked central symmetrical arrangement. Thus at La Chevrette, in Dauphiné, spathic iron envelopes quartz, and both present crystals symmetrically arranged towards a centre, from which result a radiated structure. According to M. Burat, it is the same with towanite, blende, and galena which are enveloped by the fibrous and radiated augite of the mines of Tuscany.

Rocks which have a globulous structure also especially afford us particularly clear examples of envelopment with a central symmetrical arrangement. In the Rapakivi† of Finland and in certain porphyries, the oligoclase envelopes the orthoclase, around which it forms a regular aureole. In the pyromeride‡ of Corsica, the globules are composed of felspar crystallized in needles, which start from the circumference or the centre, and which follow the direction of the radii. In orbicular diorite the felspar envelopes the hornblende, and the laminæ of the two minerals are symmetrically arranged towards

* Chiastolite.

† For this rock see Cotta—"Gesteinslehre," p. 123.—H. C. S.

‡ Ibid, p. 102.—H. C. S.

the centre, at the same time that they are grouped in concentric zones.*

Central symmetrical arrangement may visibly occur in minerals of very diverse composition. When it is tolerably regular, as in the case of the globular minerals, it gives a radial structure.

(To be Continued.)

THE EVIDENCES OF THE GEOLOGICAL AGE AND HUMAN MANUFACTURE OF THE FOSSIL FLINT IMPLEMENTS.†

BY THE EDITOR.

(Continued from vol. iii., *page* 408.*)*

AMIENS and Abbeville do not, however, enjoy a monopoly in these flint implements; they are found, apparently, all over the earth. At any rate, we can boast in our land of such treasures, and we can proudly record that the first discovered specimens belong to England. Let Amiens and Abbeville by all means be commemorated as the scenes of M. Boucher de Perthes' persevering investigations, which have furnished the incitement to the present remarkable inquiry—let the names of Boucher de Perthes, Prestwich, Falconer, Flower, and Evans, be duly honoured as the pioneers of the investigation; but let us also think of Hoxne, Grays, Ilford, Maidstone, Stanway, and the scores of other places where mammalian bones have been found in our own land—and, let us hope that our young geologists will set to work, and reap a rich harvest in the yet ungarnered fields. Does not this first recorded implement—this earliest discovered relic—(fig. 5) treasured and preserved in the Sloane collection, the nucleus of the British Museum, and entered in that old catalogue, two hundred years ago—encourage them. Does it not say in unmistakable language "Under your feet these relics may be found?"

Fig. 5.—Flint Implement found in Gray's Inn Lane, before 1750. In Sloane Collection, British Musenm. Size 7 inches by 4 inches.

There is another of these spear-shaped flints, which has obtained a great deal of notoriety in the late discussions. It was found at Hoxne, in Suffolk—a place memorable in the history of the good king Edmund, the saint and martyr—and was described, and figured in the "Archæologia," *(see cut* 9, *p.* 20*)*, by Mr. Frere, the finder, who, with remarkable acuteness, seems to have fully comprehended the value and true bearing of his discovery. His paper is, even now, an excellent epitome of the subject; and we give it at length, just as it was read in 1797, before the Society of Antiquaries of London.

* Recherches sur les Roches Globulenses: par M. Delesse. (Mémoires de la Soc. Géol., 2 ser., t. iv., p. 301.)

† Being an illustrated explanatory article of Mr. Mackie's Geological Diagram, No. VI.

"An account of flint weapons discovered at Hoxne, in Suffolk, by John Frere, Esq., F.R.S., and F.A.S., in a letter to the Rev. John Brand, Secretary; read June 22, 1797.

Sir,—I take the liberty to request you to lay before the Society some flints found in the parish of Hoxne, in the county of Suffolk, which, if not particularly objects of curiosity in themselves, must, I think, be considered in that light, from the situation in which they were found. See pl. xiv. xv.

6 7 8 9

From pl. xiv., "Archæologia," vol. xiii. Size 5 inches by 3 inches. | From pl. xv., "Archæologia," vol. xiii. Size, 7½ inches by 4 inches.

Reduced Outlines (scale one-fourth), of the Flint Implements found by Mr. Frere, at Hoxne, Suffolk. A.D., 1797.

They are, I think, evidently weapons of war, fabricated and used by people who had not the use of metals. They lay in great numbers at the depth of about twelve feet, in a stratified soil, which was dug for the purpose of raising clay for bricks.

The strata are as follows:—

1. Vegetable earth, one and a half feet.
2. Argill, seven and a half feet.
3. Sand, mixed with shells and other marine substances, one foot.
4. A gravelly soil, in which the flints are found, generally at the rate of five or six in a square yard, two feet.

In the same stratum are frequently found small fragments of wood, very perfect when first dug up, but which soon decomposes on being exposed to the air; and, in the stratum of sand, (No. 3,) were found some extraordinary bones, particularly a jaw-bone of enormous size, of some unknown animal, with the teeth remaining in it. I was very eager to obtain a sight of this; and finding it had been carried to a neighbouring gentleman, I inquired of him, but learned that he had presented it, together with a large thigh bone, found in the same place, to Sir Ashton Lever, and it, therefore, is probably now in Parkinson's museum.

The situation in which these weapons are found may tempt us to refer them to a very remote period indeed; even beyond that of the present world; but whatever our conjectures on that head may be, it will be difficult to account for the stratum in which they lie being covered by another stratum, which, on this supposition, may be conjectured to have been once the bottom of the sea. The manner in which they lie would lead to the persuasion that it was a place of their manufacture, and not of their accidental deposit; and the number of them was so great that the man who carried on the brick-work told me that before he was aware of their being objects of curiosity he had emptied baskets full of them into the ruts of the adjoining road. It may be conjectured that the different strata were formed by inundations happening at different periods and bringing down in succession the different materials of which they consist, to which I can only say, that the ground in question does not lie at the foot of any higher ground, but does itself overhang a tract of boggy earth, which extends under the fourth stratum: so that it should rather seem that torrents had washed away the incumbent strata, and left the bog-earth bare, than that the bog-earth was covered by them, especially as the strata appear to be disposed horizontally and present their edges to the abrupt termination of the high ground.

If you think the above worthy of the notice of the Society, you will please lay it before them.

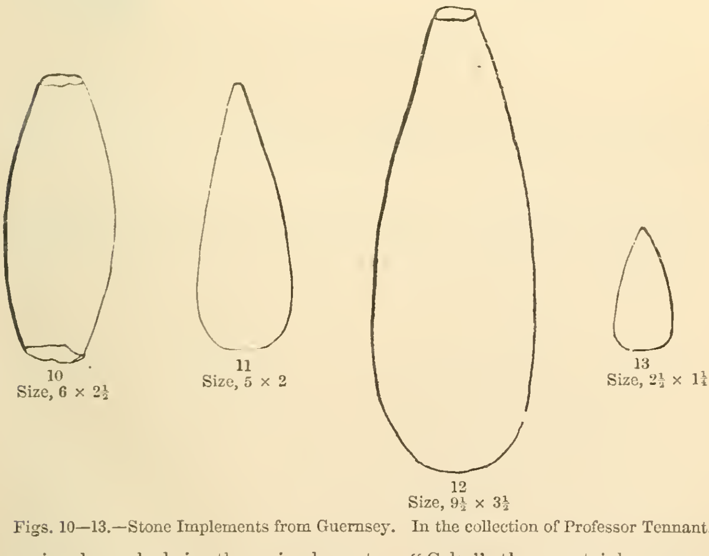
I am, Sir, with great respect, your faithful humble servant,

John Frere."

In the cases of both the above mentioned flint-implements we have distinct records of their having been associated with mammalian bones.

Having gone briefly but succinctly through some of the principal evidences that these worked-flints have been extracted from true geological formations, in fact that they are really *fossil*, we will briefly allude to the general misnomer of "celt," as applied to these relics.

The polar bear who stopped in his pursuit of the arctic voyager to turn inside out with his fumbling paws the worsted glove which the sailor had dropped to attract the beast's attention and facilitate his own escape might not have had a more puzzling article for his mental capacity than geologists and anti-



Figs. 10—13.—Stone Implements from Guernsey. In the collection of Professor Tennant.

quaries have had in these implements. "Celts" they certainly are not, whatever their former use may have been, as anyone may see who will compare them with figs. 10, 11, 12, 13, or any other representation of a true "celt," which is in fact a chisel, and wrought to a cutting edge at the broad end; while these fossil instruments are nearly or totally unwrought at the broad end, but are worked up to a more or less sharp point, which is evidently the part that was used.

Of the fossil flint-knives, arrow-heads, and javelin-points, such as we shall hereafter refer to, no doubt as to their uses can arise in the minds of any who will take the trouble to compare them with instruments adapted to the same purposes in hunting—the favourite pursuit and main source of existence of all savage tribes—which are still in use by the aborigines of various countries, or rather are known to have been so in recent times, for European tools of iron have rapidly and very generally supplanted stone-implements, even in the remotest regions. But the same definiteness of purpose or applicability is not evident in the larger and pear-shaped instruments to which we first drew attention. These, if they were used by the hand, must have been used at the point; celts, having the broad end ground or rubbed to a cutting-edge, were used as chisels, or mounted in fragments of horn or wood, as axes or hatchets.

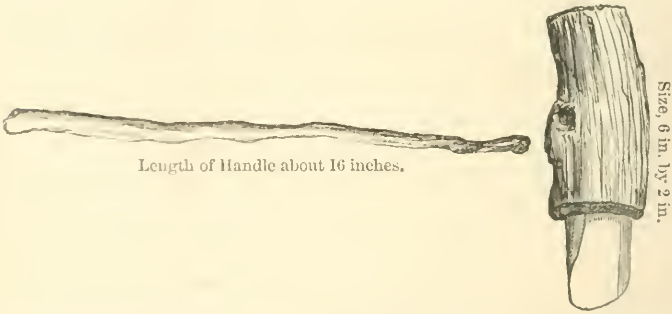


Fig. 14.—Stone Celt set in portion of Stag's-horn, with Transverse Hole for Wooden Handle. In the British Museum.

The pointed fossil implements might possibly have been used as wedges for splitting trees, and other like purposes; or bound in split sticks as battle-axes, and formidable weapons they would have made. But the most reasonable use seems to me that of spear-heads, lashed on to stout poles; and wielded by strong and active men they would have been heavy and formidable weapons against the great deer and oxen of that age of gigantic mammalia upon the herds of which primitive man—if he lived in the days of the mammoth as the association of the bones of that huge beast with these relics of the first human workmanship seems at least to prove—would have occasion and necessity to make constant onslaught for his subsistence, his clothing, and his articles and materials of daily use. Against the great elephants, tigers, and cave-bears of that age we think they could only have been used—if at all—under the pressure of the imperative necessity of personal defence, and never for the purpose of offensive attack. Hence if we are to find any traces of their uses in the shape of indentations, scars, or wounds upon the bones of the extinct quadrupeds, it should be on those of the great herbivora, and not those of the carnivora that we should expect to find them.

Professor Owen in his "British Fossil Mammalia," has noticed the injury done to a rib of a *Megaceros hibernicus*, and attributed it to the point of the antler of another deer; but now there seems more probability that the injury in question might have been effected by one of these so-called "celts." M. Lartet has also given us accounts of fossil mammalian bones bearing incisions and marks made by apparently blunt weapons, such as would have been produced by these flint-implements.

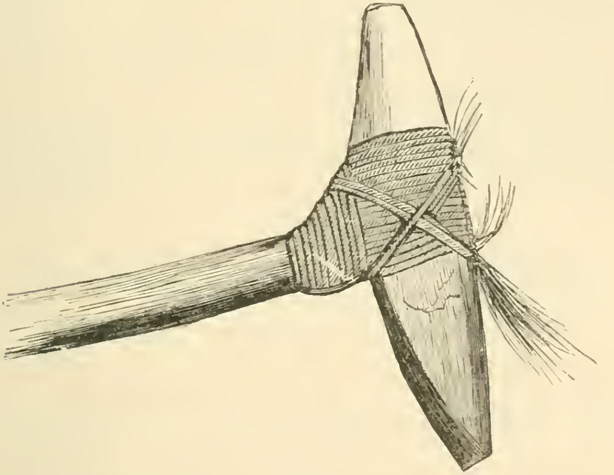


Fig. 15.—Stone Hatchet, with Handle, from New Caledonia, South Pacific Ocean. Size: length with handle, 19 inches; head of hatchet, 10 inches.

We have figured (fig. 15) a stone adze from New Caledonia, to show by a comparison with its form that the fossil implements could not have been similarly lashed on and used for the purposes for which such instruments are adapted, and which thus affords a negative evidence in favour of the idea of their being rude spear-heads.

Besides the larger spear-shaped and pear-shaped weapons, there were smaller and flatter flints, of an oval shape, which it is thought were used as sling-stones or as axes. The first of our examples of this kind (fig. 16) was found in the

Fig. 16.—Small Flint Instrument from the Gravel of Amiens. Size, 4 inches by 2¾ inches.

Fig. 17.—Small Flint Instrument from Gravel at Hoxne, Suffolk. Size, 4 inches by by 2½ inches.

drift-gravel of Amiens, by M. Boucher de Perthes; the second (fig. 17) at Hoxne, in 1797, by Mr. Frere; the latter is preserved in the collection of the Society of Antiquaries.

Fig. 18 is another and very remarkable flint-instrument, probably a lance- or javelin-head, from the superficial gravel above the London Clay, at Hornsey, in Middlesex, and now in the collection of Mr. N. T. Wetherell, of Highgate, to whom it was brought a short time since by one of the quarrymen as a fossil fish; the workman mistaking the white chalky spot at one end for the eye, and the numerous fine chippings for scales. It is about six inches long by two inches broad, and but little more than a quarter of an inch in its central thickest part.

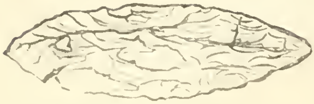


Fig. 18.—Flint Javelin or Spear-head (?), found in the Superficial Gravel above the London Clay, at Hornsey, Middlesex.

In Mr. Mackie's Diagram No. VI. there is figured from the collection of the Society of Antiquaries (fig. 12 of diagram) a very long, narrow, and remarkable flint-instrument, apparently either a lance-head or a dagger, although it may have been used for the more pacific purposes of a knife. From its

Fig. 19.—Flint Implement in the Collection of the Society of Antiquaries. Size: 10 inches by 1¾ inches.

general appearance one would suspect it to have come from some sandy or gravelly deposit, and to be of veritable geological age; but there is no entry in the Society's catalogue of either the time or place of its discovery, and it may after all be only of Celtic date. We give also another worked instrument fig. 20 (fig. 19 of diagram) contained in the same collection, but of which also no record of the circumstances of discovery are preserved. It may be a gravel specimen.

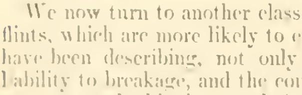


Fig. 20.—Flint Saw ? (British). In the Collection of the Society of Antiquaries of London. Size: 6 inches by 1½ inches.

We now turn to another class of fossil implements, formed of mere flakes of flints, which are more likely to escape detection than the larger instruments we have been describing, not only from their smaller size, but also from their liability to breakage, and the consequent resemblance of their broken pieces to mere natural chippings and fragments of flints. The flake-instruments are

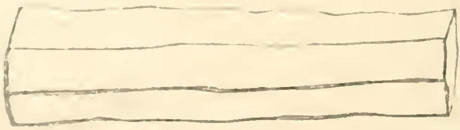


Fig. 21.—Flint-flake Knife from the Turbary of the Somme, at Abbeville. Natural size.

well known from Celtic graves, and are commonly met with amongst the relics of all savage tribes, in the form of arrow-heads, knives, dart- and javelin-points, and saws; and flake-knives and flake arrow-heads have also been met with in ossiferous cave-, and gravel-deposits, and as well as in peat-bogs, turbaries, and other similar deposits of the like intermediate age. Figs. 23 and 24 are two portions of fossil flake-knives from Kent's Hole, a large cavern rendered

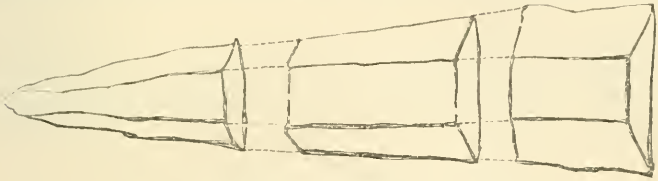
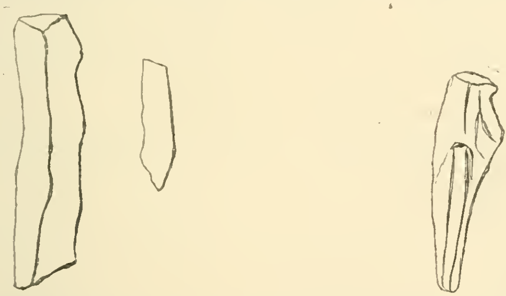


Fig. 22.—Broken Fragments of a Flint-flake Knife.

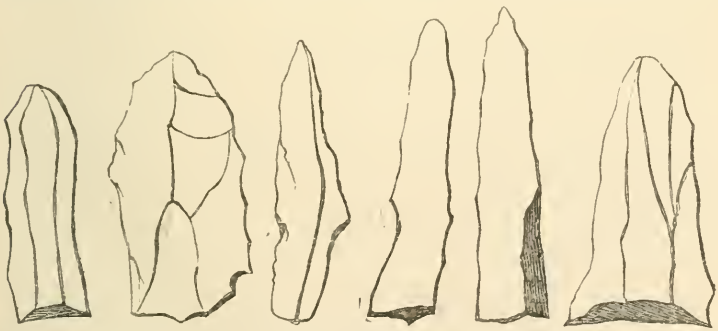
memorable by the researches of the late Dr. Buckland. These were presented to the national collection in the British Museum, by Mr. Godwin-Austen, and



Figs. 23, 24.—Flint-flake Knives, from the Ossiferous Cavern, Kent's Hole. Scale, one-fourth. Presented to the British Museum by R. A. Godwin-Austen, Esq., F.G.S.

Fig. 25.—Flint-flake Knives from the Turbary of the Somme, at Abbeville. Nat. size $4\frac{1}{2}$ inches by $1\frac{1}{2}$ inches. Collected by M. Boucher de Perthes.

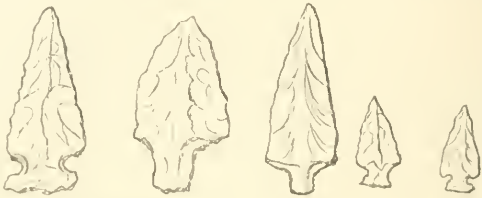
where they may be seen in the cases of the British antiquities room. Figs. 24 and 25 are portions of flint flake-knives from the Turbary of the



Figs. 26—31.—Flint Arrow-Heads from Redhill. Nat. size. In the Collection of the Society of Antiquaries.

valley of the Somme, at Abbeville, and were collected by M. Boucher de Perthes. Figs. 26 to 31 represent various forms of flint arrow-heads, from specimens collected at Redhill, in Surrey, and presented by Mr. C. Roach Smith to the Society of Antiquaries of London. These give sufficient illustration of this class of articles, whether of fossil, Celtic, or modern date. Flake-saws are met with in graves; but we are not aware that any of these have been found in any really geological formation.

The arrow-heads (figs. 32 to 36) can scarcely be said to belong to the class of flake-instruments, although formed of fragments of flints, as they have been always more or less, and sometimes elaborately, chipped and trimmed into the



Figs. 32—36.—Flint Arrow-heads from Canada. In the collection of Dr. G. D. Gibb, F.G.S., of London. Scale one-fourth.

required shapes. The specimens figured are from specimens brought from Canada, by Dr. G. D. Gibb, F.G.S., of London, and a notice by him of this class of objects is printed in the "Notes and Queries," page 422, of vol. iii.

Fig. 37. —Arrow-head of Smoky Quartz, from Peru. Nat. size, 2½ inches by 1½ inches. In the collection of C Rickman, Esq.

Fig. 37 is a specimen of this class of objects made of smoky quartz, from Peru. Such chipped arrow-heads are found in India also, and sometimes these are of "blood-stone." In other parts they are made of obsidian and other volcanic and hard rocks, and their distribution is very general. There is nothing, however, positively known as to their being of geological age, although it seems probable that many of them are; especially the American and Canadian specimens, which may belong to the very remote age of the great mammalia. Their dates of manufacture are, however, very various, and some of them are undoubtedly of comparatively modern workmanship.

We now turn to another subject—the indications we have of the *human* workmanship of the veritable fossil implements which have been found with the bones of extinct mammals. First, then, there are two or three leading facts which seem to attribute these implements to a same and primitive people, namely, the extensive geographical area over which they are found; their general resemblance to each other, whether of the large or small kinds; or from whatever country, whether England, France, Sicily, Denmark, the French African possessions, Lithuania, Poland, and, as far as we know also, Canada and America. There is also the apparent identity of the methods employed in working them to their required forms, and which is so remarkable as almost to convince us of, at least, the identity of origin and community of the probably wandering tribes by which they were made and used. The first and most powerful argument of their *human* manufacture is the unmistakeable evidence of *design*. They are evidently—a first glance satisfies us of this—*instruments* adapted to *specific* purposes. No living being *designs* or makes anything as a means to accomplish an end or purpose but *man*. No other being exhibits forethought in manufacture; none whatever. No other being uses a cutting or piercing instrument; none. They seize, tear, gore, with their claws, beaks, tusks, or horns, but they use no auxillary instrument. A monkey may tear down a branch of a tree, or cast a stone, but it makes not a club of the one, nor trims the other for a sling, an arrow, or a spear. The second, but still a most material evidence is afforded by the manner or method of the workmanship employed in producing certain definite forms of implements. Let us first take the larger pear-shaped and spear-shaped instruments. A large flint has been here taken from the chalk itself, sometimes from a gravel-heap, and by a series of chippings from the outer part or sides the desired pointed, spear- or pear-shape is attained. If we see these chippings in a stone barbed arrow-head from a Celtic grave or a tumulus, no one disputes its human workmanship any more than anyone disputes that of one of the well-known Yorkshire forgeries. But because it is asserted these fossil implements come from stratified deposits of geological age, there spring up directly voices which in loud language ignore the efforts of the hand of man and attribute —too commonly without the slightest knowledge of the implements themselves, the natural fracturage of flint, or the nature of the circumstances under which the geological formations were deposited—their regular and definite forms to the attrition of the flints with each other by the influence of waves or currents of water. Anyone who will take the trouble to chip off a flake from an ordinary flint nodule will see that the fracture gives a series of concentric arcs one beyond the other, the convexity of which always points in the direction in which the blow was struck. Anyone looking at one of these fossil implements will see the fracture of the separate flakes plainly marked out by these lines of concentric arcs and undulations, and will as plainly see that these flakings have all been made by blows given at the sides, and are broken out, because the lines of fracture all point from the outer edges or sides towards the central ridge (see fig. 1, p. 405, vol. iii., or figs. 5—9, 16, 17, vol. iv.) just as they would do if wrought by the hand of man into a *designed* and given shape, but as they never would be from casual and chance blows, which would necessarily strike in all directions just as accidentally might happen. The chippings of the flints, if by design, would be *regular* and *systematic*, which they *are*; if by natural causes, *irregular* and *unsystematic*, which they *are not*.

Figs. 38, 39.—Forgeries of Flint Implements.

Fig. 40.—Concentric Lines of Fracture in Flints.

Moreover, the flints of which these instruments are made have been selected—those of a firm unfractured substance have been chosen. Everyone acquainted with chalk districts or pebble-beaches knows how few flints are firm and solid compared with those which present more or less numerous fine divisional planes of fissure, and how readily these latter fall to pieces at a slight blow of the hammer. We find none of these fossil instruments formed of the shatterable flints, which, if accident formed these instruments, should not have been excluded from the formative chipping processes; on the other hand, we find these fossil instruments formed of remarkably hard and compact nodules, such as were likely at most only to have been battered and pitted by the waves, but which could only have been *flaked* by definite and appropriate blows struck by the hand of man.

We need not again speak of the *design* exhibited in the fossil flint knives, arrow-heads and javelin-points, about which no doubt could arise in the minds of those who would look at those articles. But the same certainty of their *human* origin is not to the inexperienced so evident when these flake instruments are broken, as they are extremely likely to be. They are then, apparently, only so many ordinary chips; but the impress of *design* clings to the smallest fragment, and from a chip a quarter of an inch in length one could almost speak with certainty. The method of manufacture of obsidian instruments by the Peruvians and South Sea Islanders gives the easiest possible solution of the process, which is comparatively easy of accomplishment in that mineral, but rather more difficult in flint, although the *method* is nevertheless the same in both. We will suppose, however, that the savage has got a block of obsidian—he first trims it to an angular form, six-sided, eight, ten, or any number of sides will do—thus, (fig. 40.) He then by a series of smart blows struck at each of the corners, *a*, *a*, *a*, (fig. 41,) splits off each of the angles, as long narrow flakes, broad at the top, and tapering away more or less to a point, and having a sharp cutting edge on either side, (as marked out by the dotted lines,) and characterised by a ridge formed by the angle of the block, passing down the front; the back being flat or very slightly convex.

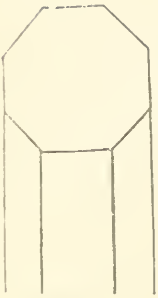


Fig. 41.

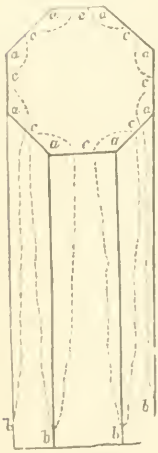


Fig. 42.

From the chipping off of the angles the block will assume the shape now indicated, (fig. 42,) its second stage, being still an octagon with the angles or corners all truncated, and presenting a flat ribbon-like band which will characterize the second set of flake-knives formed by the chipping of these truncated angles. It will be seen that the second operation reduces the block to its primitive form with sharp corners or angles; a third operation will restore again the truncated stage, and alternately each successive flaking will bring about the alternate conditions, so that all the flake knives obtained by the process will show

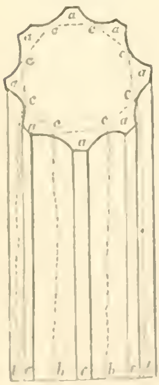
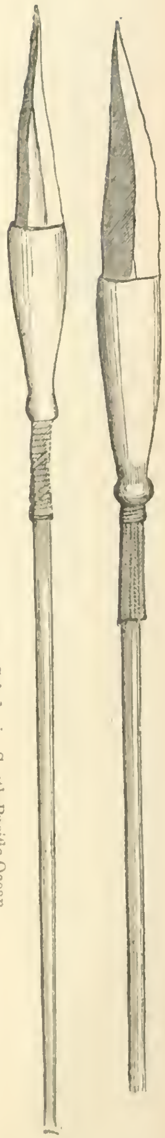


Fig. 43.



Figs. 44, 45.—Javelins, with Obsidian Point, from New Caledonia, South Pacific Ocean.

the origin and the method of flaking by the presence of a sharp ridge, or a flat band passing down the front side only, the back being alike in both cases, flat or nearly so. In this then we have a palpable and unmistakable brand, applicable alike to the modern or fossil flint instruments, and by which we can satisfy ourselves by the smallest fragment (see fig. 22, page 25) of a broken specimen, because it must be borne in mind that such is not to be produced by any natural breakage, but can only be effected by the *design* which brings the block at *first* into the required shape, and *then* causes the fracturing blows to be given in a peculiar and *designed* manner. Try your hand at breaking out these flakes. At first you will fail miserably, Persevere and you will acquire the *knack* with precision and certainty. And this *knack* being peculiar, the character of the flakings are peculiar also, and not such as would result from natural pulverizing or breakage by collision with each other.

And now I approach another topic in this interesting investigation, on which I wish to speak with the utmost caution and guardedness, and with courtesy and consideration to the feelings and sentiments of every one of my readers. I wish to offend no prejudices or belief—to interfere with no doctrines, theory, or faith—but one important reflection will arise at this stage in my mind, and therefore, probably, also in the minds of others. What were these first men like? Did they stand erect and noble? Were they high intellectual beings, the fit progenitors of a lofty-minded and world-conquering race? The voice of Science is dumb.

Darwin has lately given powerful arguments in favour of the development doctrines, and the natural production of higher and higher forms of animal and vegetable life, by the amelioration and improvement of species. We look from the apes and monkeys to the ourangs and chimpanzees, and we pause before the wonderful semi-human expressive face of the gorilla—a stalwart active brute—through whose unearthly eyes something not unlike human intelligence seems to beam. We look at its thick lips and flattened nose, and our thoughts turn involuntarily to the bandied legs, thick lips, low forehead, and black tawny skin of the wool-headed negro, and for one moment we may think "Good heavens, *can* there be a nearer link of men and brutes?" In days gone by—days gone by ages ago—in those days when the mammoth and Irish elk, the cave-bear and hippopotamus dwelt in our land, was there then a nearer closer link of man and beast? I know not—I speak not—but such a thought will arise when we look at the great four-handed beasts of our own day on the one hand, and on the other regard the primitive *rudeness* of workmanship of these fossil instruments. The whole race, tribe, commonality, or nation—be it what it may—of primitive men seems possessed of but two or three ideas in the manufacture of these flint-implements. From Denmark to our own Island—over regions now the seats of many nations — they *chipped* their flints and formed their weapons on the same primitive plans, by the same primitive means. There is no effort whatever at ornamentation: nor even of polishing or smoothing. The makers of them do not seem to have attained to the idea of rubbing down to a point or an edge, and never to have gone beyond the first rough efforts of chipping out. Low as we are accustomed to regard the Celtic race in the scale of civilization, these first men must have been much lower and yet one would not be willing to believe them unendowed with unperishing souls like ourselves.

Curious low fronted skulls have been found in caves, in fields near ossiferous or bone-bearing fissures—have been found under circumstances of suspicious proximity to bone-deposits; but no *real* evidence is yet obtained. Men's minds have not yet been directed to this point, or men have shirked this topic in their investigations. I do not attempt to draw a conclusion in these remarks: I direct attention merely to a point of necessary investigation, as one on which evidence must sooner or later be accumulated; and the more workers there are in the field, the greater and more powerful will be the testimony to the truth.

This leads, of course, to the consideration of the more direct question whether human bones have ever been found in the ossiferous caves and fissures, and ordinary mammaliferous deposits? Undoubtedly they have; Buckland, Schœmerling, and many other writers have recorded human skeletons in cave-and other deposits containing mammalian remains; but such has been the constant practice of ignoring any true association of such remains with those of mammalia in the same deposit—in fact an utter refusal to admit any evidences of a greater antiquity than some 5,000 or 6,000 years for the creation of the human race—so that authors neglected such evidence when they found it, or wrote obscurely and timidly about it, even when it was forced in an undeniable manner upon their notice. Hence the reason why we have few or no illustrative cases. It may be worth while here to allude to another class of existing antiquities—the great monoliths and other stone monuments—found alike in our own and the remotest and most distant and widely separated lands, whether as the supposed "Druid's circles," "sacrificial altars," and rock-basins of our own country, the raised stones of India, or the rock inscriptions of Arabia. Are these ancient monuments to be associated with the progress of the primitive race to whom we attribute these chipped implements of flint? Again, I answer not, I merely suggest. In this important investigation no man is yet, perhaps, prepared to answer. We know not, in fact, where we are—we are as it were in a strange land which we have not yet explored, amongst a strange people whose language we have not yet learnt. Soon, perhaps, we may master the task—or it may be long before we unravel the mysteries. "Labour conquers all things," says the Latin proverb, and we must labour on perseveringly to make out the first history of our race.

I will now turn to another phase of the great geological question we are investigating. Of what age—what relative geological age, that is—are the mammaliferous deposits in which these flint implements are found? The great age of the drift gravels and other superficial mammaliferous deposits has never been rigidly determined. We know that they belong to, or preceded, or were formed just after the memorable Glacial era—when glaciers extended from the mountains of Wales into the valleys now filled with their debris, as they now do in Switzerland; when the great Swiss glaciers themselves were miles larger in extent: when icebergs dropped as they melted into the sea, under which a great part of our island was then submerged, the great stones and rocks uplifted from distant coasts, and strewed our island and a great part of similary sunken Europe with gigantic boulders and mud, forming those deposits known as the Boulder-drift and Till. The necessity of investigating rigorously the origin of these superficial deposits, has, since the question of the first appearance of man, become imperative; although the progress made must be necessarily slow, and the work often unsafe from the difficulty of always detecting the intermingling of modern matter, to which these nearly superficial beds from their proximity to the actual surface, have been of necessity subject. But such difficulties must no longer stand in the way, they must be boldly met and fairly grappled with; and in this respect Prestwich, Falconer and other geologists are doing their duty. We must no longer be content to believe that one kind of mammoth was associated with one kind of rhinoceros, and another species of mammoth with another species of rhinoceros; but we must know whether for certain this is so. The latest researches tend to show that the true mammoth lived in this island at least, both before and after the Glacial epoch. If so, we must look to the oscillations of our land and the formerly submerged tract of Europe for the explanation. Perhaps we may consider that as the submergence of this area took place in the glacial era, the great pachyderms were of necessity driven back in their terrestial range by the sea as it encroached; and as the submerged area towards the close of the glacial epoch began to be re-elevated and to rise again out of the waters, the *Elephas primigenius* and some of its associates which were able to outstand the inclemency of that severe period, wandered back over their ancient territory, and mingled with the newer forms which similarly had wandered from other regions during the changes of land and sea; and thus the northern and the perhaps southern forms met together in the same temperate zone. We know from Ed. Forbes' studies that the mollusca of our district migrated thus during the glacial age into Italy, and that some have since returned to our shores, while others have not yet reached again their ancient habitats, but are steadily working on towards it. We know also that in the deep holes and pits of the ocean there still are colonies of the old northern forms which spreading over the submerged area of those cold times have not been able to extricate themselves from such cavities, from which their dwarfed descendants are now to be dragged up. This is a speculation which I throw out for young and active geolgists to take up. My time is too fully occupied with the business and cares of life to allow me to devote much time now to field-studies, but there are many who are glad of holidays, and who will be glad to know what is useful work to do in their pleasure-takings; for them it is I throw out these ideas, not being selfish enough to wish to retain them when I cannot myself work them out.

In some of the Glamorganshire caves Colonel Wood and Dr. Falconer have found a deposit containing *Littorina* (perriwinkle) shells, and which deposit is comparable with the deposit often associated with the raised beaches of our coasts known to geologists under the name of "head," and which is equivalent to parts of the so-termed sub-aërial deposits of Mr. Godwin-Austen. Both above and below the cave-deposits, containing recent species of marine shells, the bones and grinders of *Elephas primigenius* are found, as they are also in other places, commingled with the remains of the hitherto supposed younger and older races of the ancient mammalia.

With respect to the ancient mammoth, we know that it was clothed with a coating of long hair, by which and its thick skin it was well provided against the inclemencies of the glacial age; but how is it with the hippopotamus—so like, so undistinguishable from the existing *H. major*, the inhabitant of torrid climes. I confess this creature's remains are a puzzle to me; for granted that it could withstand the cold of that period, our knowledge of the present habits of the species does not permit us to believe that it could subsist without water.

But I will proceed no further with the discussion of the habits of the great mammalia. I wished to exhibit in its true state the knowledge we possess of the first relics of the human race, and to point out the marks and character which indicate on the worked flints the evidences of human handling.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—November 21, 1860.

"On the Geology of Bolivia and Southern Peru." By D. Forbes, Esq., F.R.S., F.G.S. With Notes on the Fossils by Prof. Huxley, F.R.S., Sec. G.S., and J. W. Salter, Esq., F.G.S.

The author described the Post-Tertiary formations of the maritime district. These beds, containing existing species of shells, occur at various heights up to forty feet above the sea-level. Guano deposits are frequent along the coast, and deposits of salt also in raised beaches a little above the sea. The author could not verify Lieut. Freyer's statement of *Balani* and *Milleporæ* being attached high up the side of the Morro de Arica, a perpendicular cliff at the water's edge; indeed, from the state of old Indian tumuli along the beach, and other circumstances, the author believes that no perceptible elevation has here taken place since the Spanish Conquest, although such an alteration of level has occurred in Chile. The sand-dunes of the coast, and their great mobility during the hot season, were noticed. From Mexillones to Arica the coast is steep and rugged, formed of a chain of mountains, three thousand feet high, consisting of rocks of the Upper Oolitic age. At Arica the high land recedes, leaving a wide plain formed of the debris of the neighbouring mountains; and in the middle of this area was observed stratified volcanic tuff contemporaneous with the formation of the gravel.

The saline formations were treated of as three groups, according to their height above the sea-level, and were shown to be much more extensive than generally supposed, extending over the rainless regions of this coast for more than five hundred and fifty miles. They are mostly developed, however, between latitudes nineteen degrees and twenty-five degrees south. These salines are supposed to have originated in the evaporation of sea-water confined in them as lagoons by the original ranges of hills separating them from the ocean. The nitrate of soda had, in the author's opinion, resulted from the chemical reactions of sea-salt, carbonate of lime, and decomposed vegetable matter (both terrestrial and marine). The borate of lime, occurring with the nitrate, is connected with the volcanic conditions of the district, and was produced by fumaroles containing boracic acid. Where the highest range of salines extend beyond the rainless region, they are much modified in the rainy season, and generally take the form of salt plains encircling salt lakes or swamps.

The great Bolivian plateau, having an average elevation of thirteen thousand or fourteen thousand feet above the sea. consists of great gravel plains formed by the spaces between the longitudinal ranges of mountains being filled up by the debris of these mountains. The most western of these consists of Oolitic debris with volcanic tuff and scoriæ; it bears the salines above-mentioned, and is nearly destitute of water. The central range of plains, formed from the disintegration of red sandstones and marls, with some volcanic scoriæ, is well watered. The third range consists of plains made up of the debris of Silurian and granitic rocks, and is auriferous. The thickness of this accumulation of clays, gravel, shingle, and boulders is immense at places. At La Pas it is more than one thousand six hundred feet. Contemporaneous trachytic tuff was found also in these deposits. In fresh-water ponds on this plateau, at a height of fourteen thousand feet (lat. fifteen degrees south), Mr. Forbes found abundance of *Cyclas Chilensis*, formerly considered to be peculiar to the most southern and coldest part of Chile at the level of the sea (lat. forty-five degrees to fifty degrees south).

The volcanic formations were next noticed. Volcanic action has continued certainly from the pleistocene age to the present. The line of volcanic phenomena is nearly continuous north and south. Cones are frequent, some of them twenty-two thousand feet high and upwards; but craters are rare. Volcanic matter, both in ancient times and at present, has in a great part been erupted from lateral vents, often of great longitudinal extent; recent trachytic lavas from such orifices have covered in some cases more than one hundred miles of country. Besides trachyte, there are great tracts of trachydoleritic and felspathic lavas. On the whole, in these South American lavas silex abounds, and it has been the first element in the rock to crystallize; whereas apparently in granite quartz is the last to crystallize and form the state of so-called "surfusion." Diorites (including the so-called "Andesite") occur in force along two parallel north and south lines of eruption in this region, reaching through Chile, Bolivia, and Peru, for more than forty degrees of latitude. These diorites, and more especially the rocks which they traverse, are metalliferous; and the author looks upon the greater part of the copper, silver, iron, and other metallic veins of the countries as directly occasioned by the appearance of this rock.

Shales and argillaceous limestones, with clay-stones, porphyry-tuffs, and porphyries form the mass of the Upper Oolite formation of Bolivia, equivalent to Darwin's Cretaceo-Oolitic Series of Chile. At Cobija they are traversed in all directions by metallic veins, chiefly copper, and which, as before mentioned, appear to emanate from the diorite.

Red and variegated marls and sandstones, with gypsum, and cupriferous and yellow sandstones, and conglomerates, come next in order; they have a thickness of six thousand feet, and are much folded and dislocated. These are considered by the author to resemble closely the Permian rocks of Russia. Fossil wood is not uncommon in some of these strata, which extend for at least five hundred miles north and south.

Carboniferous strata occur chiefly as a small, contorted, basin-shaped series of limestones, sandstones, and shales, with abundant characteristic fossils.

The quartzites which are generally supposed to represent the Devonian formation in Bolivia, but which the author is rather disposed to group as Upper Silurian, are really not of very great thickness; but are very much folded, and perhaps are about five thousand feet thick.

The Silurian rocks (perhaps fifteen thousand feet thick) are well developed over an area of from eighty thousand to one hundred thousand miles of mountain-country, including the highest mountains of South America, and giving rise to the great rivers, Amazon, &c. These slates, shales, grauwackes, and quartzites yield abundant fossils even up to the highest point reached, twenty thousand feet. The problematical fossils known as *Cruziana* or *Bilobites* occur not only in the lower beds, but (with many other fossils) in the higher part of the series.

Lastly, the differences between the sections made by M. D'Orbigny, M. Pissis, and the author were pointed out, though for the most part difficult of explanation. D'Orbigny makes the mountain Illemani to be granite; it is slate according to the author. M. Pissis describes as carboniferous the beds in which Mr. Forbes found Silurian fossils,—and so on.

"On a New Species of *Macrauchenia (M. Boliviensis)*." By Prof. T. H. Huxley, F.R.S., Sec. G.S., &c.

Some bones, fully impregnated with metallic copper, which had been brought up from the mines in Corocoro in Bolivia were submitted to Prof. Huxley for examination. The mines referred to are situated on a great fault, and the bones were probably part of a carcass that had fallen in from the surface,—the copper-bearing water of the mines having mineralized them. A cervical and a lumbar vertebra, an astragalus, a scapula, and a tibia show complete correspondence in essential characters with those bones of the great *Macrauchenia Patachonica* described by Prof. Owen in the Appendix to the "Voyage of the Beagle," but the relative size and proportions of the vertebra, the tibia, and the astragalus indicate a distinct species, much smaller and more slender; and in some points of structure this new form *(M. Boliviensis)* approaches more nearly to the recent *Auchenidæ* than to the larger and fossil species. The fragments of the cranium show some peculiarities of form; but, on the whole, it has many resemblances to that of the Vicugna.

Prof. Huxley pointed out that this slender and small-headed *Macrauchenia* may have been the highland-contemporary of the larger *M. Patachonica*; just as nowadays the Vicugna prefers the mountains, while its larger congener the Guanaco roams over the Patagonian plains.

Lastly it was remarked that, as *Macrauchenia* was an animal combining, to a much more marked degree than any other known recent or fossil mammal, the peculiarities of certain artiodactyles and perissodactyles, and yet was certainly but of post-pleistocene age, it presents a striking exception to the commonly asserted doctrine that "more generalized" organisms were confined to the ancient periods of the earth's history. For similar reasons the structure of the *Macrauchenia* is inimical to the idea that an extinct animal can always be reconstructed from a single tooth or a single bone.

"On the Palæozoic Fossils brought by Mr. D. Forbes from Bolivia." By J. W. Salter, Esq., F.G.S.

The fossils of Carboniferous age brought home by Mr. Forbes are the well-known species described by D'Orbigny. Several are identical with European forms (as *Productus Martini*, &c.), and are cosmopolitan; others are peculiar to the district (*Spirifer Condor*, *Orthis Andii*, &c.).

Mr. Forbes has brought a "Devonian" trilobite *(Phacops latifrons* or *Ph. bufo*), in a rolled pebble, from Oruro: it is a widely-spread species. Another allied form was found by Mr. Pantland, many years back, at Aygatchi. In other respects the "Devonian" evidence is scanty.

In Mr. Forbes' fine collection of Silurian fossils none of D'Orbigny's ten Silurian species occur; nearly all are such as are met with in Lower Devonian and in Upper Silurian rocks—*Tentaculites*, *Orthis*, *Ctenodonta*, *Pileopsis* (?) *Strophomena*, *Bellerophon*. South Africa and the Falkland Isles yield a similar fossil fauna. The *Bilobites* in this collection differ, some of them probably generically, from D'Orbigny's figured species. A little *Beyrichia* from the upper part of the Silurian series in Bolivia appears to be like a North American form figured by Emmons as Silurian.

December 5, 1860.

"On the Structure of the North-west Highlands, and the Relations of the Gneiss, Red Sandstone, and Quartzite of Sutherland and Ross-shire." By Professor James Nicol, F.G.S.

Geologists' Association.—This Society re-assembled for the winter Session on the 5th November, at 5, Cavendish Square, when the Rev. Walter Mitchell gave a lecture "On the Application of Crystalography to Mineralogy and Geology."

Crystalography, it was stated, was capable not merely of explaining many facts connected with mineralogy, but also of throwing light on various phenomena belonging to geology. Thus, with respect to the latter science, the cleavage of crystals illustrated the great cleavage planes of the stratified metamorphic rocks, and their modified form assisted in determining the temperature at which strata had been produced. The views and researches of Mr. Clifton Sorby were dwelt upon, and the geometrical laws of Crystalography treated at some length

Dec. 3. 1860.

Mr. Mitchener read a paper on a New Red Sandstone quarry at Stourton, in Cheshire. This quarry is remarkable for the abundance of reptilian footprints which it contains.

Mr. Pickering presented to the Association a very fine collection of land- and fresh-water fossil shells from the Upper Tertiary deposits at Copford, in Essex, accompanying his observations by an interesting paper descriptive of the localities where they were obtained; and referring also to other brickfields and deposits at Fisherton, West Hackney. Reculvers, and Kennet Valley.

LIVERPOOL GEOLOGICAL SOCIETY.—Oct. 23rd, 1860.

The following papers were read:—

"On Fulverites from the Red Crag of Suffolk." By Henry Duckworth, Esq., F.R.G.S. and F.G.S.

"On the Geology of the Neighbourhood of Shelve, Shropshire." By George H. Morton, Esq., F.G.S.

This paper was illustrated by sections; also by a large and interesting collection of both upper and lower Silurian fossils collected in the district by the author of the paper and several other members of the society. The longitudinal range of hills present very high land to the east of Shelve. Reposing thereon are the Stiper Stones, rugged hills of siliceous sandstone, dipping west-north-west, the summits being about one thousand six hundred feet above the level of the sea. These are considered to represent the Lingula flags of North Wales. Small cavities are common in the hard sandstone, some of which Mr. Salter considers to show traces of Lingulæ. Annelide-burrows have also been observed. Above these rocks, which are some three thousand feet thick, is a series of dark slaty strata, containing the following fossils:—*Didymograpsus geminus*, *Ogygia Portlockii*, *Æglina binodosa*, *Theca simplex*, *Cucullela anglica*, *Redonia complanata*, *Lingula plumbea*; also one or two species of Orthoceras, and several indistinct forms. These have been found in the lowest accessible strata, and may be considered the earliest fossils in the district. The Llandeilo rocks, above the Stiper Stones, are about fourteen thousand feet thick. The strata dip sixty degrees and seventy degrees, and at smaller angles. Excepting in particular beds, fossils are rarely to be found; but in several places they occur in profusion, such as *Dictyonema sociale*, *Ogygia Burchii*, *Bellerophon perturbatus*, all of common occurrence in the upper Llandeilo. *Glyptocrinus basalis*, (McCoy,) has also been found associated with *Trinucleus Lloydii*, and *Orthis striatula*, &c., high in the series at Meadon Town. Many of the Shelve fossils are figured in the second edition of Siluria.

The "Corndon," the highest isolated hill in the locality, is a great outburst of trap rock. Beds of volcanic ashes several feet thick, are interspersed with strata several feet thick, containing organic remains, at Marrington Dingle. At Hope quarry, two miles from Shelve church, the upper (Silurian) Llandovery rock is seen, reposing unconformably upon rounded bosses of trap and Llandeilo rock. Near that place are high cliffs of contorted strata. The district is of extreme interest to geologists; for within a circular space of country some seven miles across, so many geological phenomena are to be studied under great advantages.

Dec. 11, 1860.

Thomas Urquhart, Esq., presented to the "Liverpool Free Museum," through the medium of the society, a beautiful series of Devonshire fossils, under the name of the "Pengelly Collection," many of the specimens having been cut and polished in order to show their internal structure, Mr. Morton made some remarks upon them, and on the geographical distribution of Devonian fossils in Europe.

The following paper was then read.—

"On the Oolite beds of Yorkshire as compared with their equivalent deposits in Wilts and Gloucestershire. By W. S. Horton, Esq.

This communication was illustrated by a vertical section taken from Swindon to Birdlip, and compared with one of the Yorkshire coast from Filey to Whitby. also a horizontal one from Oxford to Shortover Hill. After a short description of each bed, down to the cornbrash, reference was made to the extreme variation exhibited by the succeeding strata, which were co-ordinated as follows:—

Yorkshire.	*Wilts and Gloucestershire.*
Cornbrash . .	Cornbrash.
Upper Shale and Sandstone	Forest Marble, Bradford Clay.
Bath Oolite . .	Bath Oolite.
Lower Shale and Sandstone	Fuller's Earth.
Inferior Oolite . .	Inferior Oolite.

Both the upper and lower shales and sandstone are of fresh-water or estuary origin, and contain numerous plants, with *Equisetum columnare*, sometimes retaining its erect position, and occasional thin seams of imperfect coal. The upper series may be observed to the south of Scarboro', in Gristhorpe Bay. At Stainton Dale and Peak Hill, which forms the south side of Robin Hood's Bay, the lower series attain their greatest development, and are upwards of four hundred feet in thickness. At this spot the whole of the strata, from the Bath Oolite to the Upper Lias inclusive, may be observed in one grand section, which attains an elevation of nearly six hundred feet above the beach. The Upper Lias forms an undercliff, from which the superincumbent Lower Oolite strata rise almost perpendicularly, and are all but inaccessible.

NOTES AND QUERIES.

An "Early English" view of Adhemar's Theory.—We are justified in designating many geological notions, introduced fifty years ago, as "Early English;" for the like simple form of a first-pointed window they have served the framework for an after-filling of thought-tracery, and have not suffered an obscuration from subsequent additions. This is particularily noticeable in theoretical geology; no theory, either relating to physical or palæontological geology has appeared upon the stage in its full dimensions, but like other great results of thought, has been built up slowly and added to in after times. As an example of this, I wish to bring before the notice of your readers, an early germ of the "Periodicy of Deluges," theory of M. Adhemar. I find it as an article in an old magazine, bearing date "February 4, 1812." The article is a long one, but the following intelligible *resumè* concludes it:—

"The following are the general deductions, which the preceding facts and reasonings seem to establish.

1. That the changes upon the earth's surface, and the consequent phenomena of the strata and the fossil remains, are referable to certain known motions of the earth as a planet.

2. That those motions are the revolution of the perihelion point, (a line of apsides,) in twenty thousand nine hundred years, producing opposite effects in both hemispheres every ten thousand four hundred and fifty years, and the diminishing obliquity of the ecliptic at the present rate of a degree in six thousand nine hundred years.

3. That the perihelion forces, in varying their declination, gradually accumulate the seas in that hemisphere to which they are perpendicular; and that the gradual accumulation takes place in either hemisphere, while the point of the maxima advances through twenty degrees of declination in a period of about three thousand four hundred and eighty eight years.

4. That the accumulation of the seas in that hemisphere, in which lies the direction of the perihelion parallel is a consequence of the accumulated centripetal force, which produces or requires a corresponding increase in the centrifugal force, or oscillating momentum of the waters.

5. That the increments of quantity and momentum of the seas act by slow degrees on the land of the affected hemisphere, so as to produce sufficient space for their own accumulations, till in sufficient time the space occupied by the land is reduced in proportion to the accumulating spaces occupied by the seas.

6. That as the seas encroach on the land in one hemisphere they retire from the other, on the known principle of their equilibrium; but, during the operation of the perihelion maxima, they are also accumulated in volume sufficient to make new encroachments in the land, adding more and more to their momenta in each following year.

7. That (in 1812,) the perihelion forces operate in maxima on the 31st of December, over the parallel of twenty three degrees seven minutes south; that these forces are now moving northward, at such a rate as that in the year 4,719 they will arrive at a middle southern declination; in 6,463 will act over the equator; in 8,207 will advance to a middle northern declination, producing sensible effects on that hemisphere; and, between the year 8,207 and 15,184 will probably be the means of covering the northern hemisphere with sea, nearly as the southern hemisphere is covered at present.

8. That in tracing the progression of these forces through former periods, it appears that they passed the equator to the south about the year 4,002 before Christ, producing probably such terrestrial phenomena as those described in the first chapter of Genesis; and that they reached a middle southern declination about the year 2,258, producing probably such sensible effects in that hemisphere, as are described in the Mosaic and other accounts of the deluge.

9. That this motion of the perihelion forces over different parallels of terrestrial latitude, by producing an alternate prepondency of seas in both hemispheres, sufficiently accounts for the marine strata, and for all the marine phenomena observed upon or under the surface of the land, the gradual operation of chemical agencies being sufficient to account for the substantial changes in the bodies themselves.

10. That, if the frequent discovery of tropical remains in the latitude of Britain, be considered as evidence that these remains were natives of these latitudes, the change of climate may be referred to the diminished angle formed by the planes of the equator and ecliptic, which takes place at the rate of fifty-two seconds in a century, and of a degree in above six thousand nine hundred years; and which would have been equal to forty-five degrees at seven revolutions of the perihelion point, or one hundred and forty-nine years ago."

This paper is signed "Common Sense." It certainly may take rank as an honoured curiosity of geological literature.—George E. Roberts.

Flint Implements in the Drift. — The recent finding of some Flint Implements, evidently the work of man, in a stratum which geologists have been accustomed to consider of a date long anterior to the human era, has given rise to much discussion and conjecture; some appearing ready to admit, (though no human remains were found with them) that this discovery carries back the creation of man to an almost incalculably remote period; though so many existing facts tend to demonstrate his comparatively recent origin — facts that are quite independent of scripture-chronology, or the testimony of tradition.

By what means these manufactured flints become imbedded in the formation referred to is a question that, perhaps, can never have a perfectly satisfactory solution; but an idea that seems to have some possibly explanatory bearing on the point, was suggested to me in reading the other day an account of the construction of the Thames Tunnel.

In the course of making the excavations for this work, the difficulties that arose from the nature of the soil in some parts induced the contractors to procure a diving bell, for the purpose of examining the bottom of the river. On the first inspection that took place by means of this machine, a shovel and hammer were left on the spot by the divers; but these tools were, contrary to their expectations, nowhere to be found on their next visit. In the progress of the excavation, however, while advancing the protecting wooden framework, this missing shovel and hammer were found in the way of it, having descended at least eighteen feet into the ground, and probably resting on, or mixed up with some ancient deposit. Supposing these articles had not been recovered by the excavators; and that the soft stratum through which they sunk so deeply had, by some geological changes in the locality, become solidified, and encrusted with several layers of fresh soil, and that some future geologist had found the lost hammer and shovel in the position described, it would, doubtless, have furnished as strong an argument in that day for the vast antiquity of the human race, as the discovery of these said flint implements in the drift has done in our own.

I am not aware of what material the superincumbent stratum above the drift in that place is composed; but, however compact *now*, it may possibly in a former age have been sufficiently liquified by some aqueous irruption or submersion to cause substances of the specific gravity of flint to sink through it; as the silex has evidently done through the chalk in a fluid state, or as our shovel and hammer did through the soil in the river.

Whatever difficulties may attend this hypothesis, they certainly are not greater than are involved in the startling, and wholly unsupported assumption that the late flint discovery proves man to have existed before the straits of Dover were formed, or the mammoth and other fossil animals had become extinct.

After all, it may perhaps be a question whether surmises and speculations of this kind are at all needful in the present case—whether geologists themselves have not occasioned all the doubt and mystery respecting these flint-instruments, by assigning an antiquity to the Drift formation which does not belong to it; assuming a fact which is only theory based on some erroneous data. Indeed, between the advocates for the *remote* and those for the *recent* creation of man, it is solely a question as to the authenticity of the respectively ascribed dates, or which of these widely varying periods has the greatest weight of probability or evidence to support it; and here, apart from the Mosaic account of this event, all the past history and present state of man upon earth tends to prove (in geological language) his *modern* introduction on our globe—that he was the last, as well as the most perfect of all the great and marvellous works of God.

If, therefore, there are valid reasons for concluding that man has not been in existence more than somewhere about six thousand years, the theory that would give him a date of forty or fifty thousand, especially if founded only on the discovery of wrought flints in so equivocal a formation as the Drift, cannot be considered to be of sufficient authority to shake the generally entertained belief on the subject.—QUÆRE.

ROMAN ANTIQUITIES UNDER BOG EARTH AT CANTERBURY.—Dear Sir,—A large pipe drain is being laid down in Canterbury, the course of it running the whole length of the city from the houses in Barton Fields, beyond the London and Chatham Railway on the Dover Road, to the River Stour at East Bridge.

The cutting is from ten to fifteen feet deep. In one part of the line the workmen came to a stratum of bog earth, lying at about nine feet below the pavement. On each side of the black earth, and at the same depth, remains of Roman pottery, and, apparently, Roman foundations of buildings were found. These men also dug up some ornaments for the person, and other similar things. Some of this earth I have subjected to the process of boiling in acid, and upon examining with the microscope the residue, I found various *Diatomaceæ, Coscinodisci, Naviculæ*, &c.

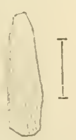
It is wonderful how widely these minute organisms are disseminated! At first I thought the black earth might be the accumulation of a large cesspool; but I think the discovery of these fresh-water organisms will make it apparent that the bog was the bed of an ancient stream running into the River Stour in the time of the Romans.—I am, yours, &c., JOHN BRENT.

RED AND WHITE CHALK OF YORKSHIRE.—Dear Sir,—In the Geologist for the month of November, 1860, I perceive some notes by Major-Gen. Emmett, R.E., F.G.S., on the above-named formations, which, if not corrected might be the cause of some disappointment to those of your readers, who, during the summer months may visit this neighbourhood, and gather fossils from the red chalk at Speeton; and the white chalk at Sowerby, Manton, Flamborough, Buckton, Bempton, Speeton, &c. What I wish to say on the above subject is, that the red chalk is not found any where nearer Flamborough than at Speeton. This fact is fully stated in the Rev. Thos. Wiltshire's Monograph on the "Red Chalk of England," published at your office, as also in the Geologist, vol. ii., p. 261.

I would further observe, that, although much of the red chalk at Speeton is hard, yet there is, also, much of this chalk which is quite soft—so much so that it can be crushed with ease between the finger and thumb. I have never yet washed this soft chalk for the sake of its foraminifera; but I have not the least doubt that those who wish to do so would find it equally prolific in fossils, if not more so than the harder chalk.

The white chalk at Sowerby, near Flamborough, is much softer than any part of the same formation at Flamborough, Bucton, Bempton, or Speeton. All the chalk in the latter places are remarkably indurate; and, in fact, from Flamborough Dyke on the south of Flamborough, around the Head, and as far as the cretaceous formation extends on the north side of it, we find all the chalk very hard indeed, yet we have many softer portions of white chalk, both at Sowerby and in the pits in and around Bridlington, so that any person who wishes to procure soft chalk, either red or white, out of which they want foraminifera, may procure any quantity they may think proper; and I should like to exchange a quantity of these soft rocks for a mounted specimen of each variety of foraminifera found therein.—E. TINDALL, Bridlington.

INSECT-REMAINS IN THE PALUDINA BEDS AT PECKHAM.—DEAR SIR,—Mr. Rickman, in his paper read before the Geological Society on the 7th November, stated that he had not found any insect-remains in the Paludina bed at Peckham. This has caused me to regard with renewed interest a fossil which I obtained on breaking open a mass of this deposit last spring. From a comparison with the figure and description given by Mr. Westwood, in his paper on fossil insects, (Geol. Journ., vol. 11, p. 381,) of a specimen from the Corfe Clay, it appears to me that my fossil is an elytron of a small Beetle. As Mr. Rickman expressed doubt, in a letter which you published a few months ago, as to the correctness of the opinion which a friend of mine had formed with regard to a specimen in his possession, I wished, before I announced the presence of insect-remains in the Peckham beds, to obtain the opinion of some competent authority. I therefore enclose a sketch, and shall be pleased to know if you consider the subject worthy of your attention. I have another specimen very similar to this, but not so perfect. I have also another one, smaller and rather different in shape, but similarily marked with striæ.



Insect Remains from the Paludina Bed at Peckham.

I enclose also some specimens belonging to a friend, one of which is different from any of those in my possession.—Yours, &c., C. E. EVANS, Hampstead.

These specimens have been forwarded to us; and through the kindness of Mr. H. Woodward have been submitted to the examination of Mr. F. Smith, of the British Museum, whose opinion is expressed in Mr. Woodward's letter.

Dear Sir,—Mr. Fredk. Smith has looked at the Peckham specimens with me, and the result arrived at is as follows:—Three specimens are not determinable; two other perhaps are not insect at all; one is the elytron of a species of Curculionida, genus Strophosomus? or Cueorhinus? and another an elytron of a species of Elater.—Yours truly, Henry Woodward.

Drift in the Southern Hemisphere.—Dear Sir,—In the course of my geological readings, I do not gather much knowledge regarding the prevalent direction of Drift in the southern hemisphere. If you could kindly give me any information respecting it, through the medium of that interesting department, the "Notes and Queries" of the Geologist Magazine, you would much oblige, your very obedient servant.—J. Curry, Boltsburn, Eastgate.

New Species of Raia from Monte Bolca.—From Count Marschall, we learn that Professor Molin has lately discovered three new species of the genus *Raia* among the fossil fishes of Monte Bolca; and that this Tertiary fish-fauna, generally supposed to be analogous with that of the Mediterranean, exhibits on close examination a somewhat tropical character.

REVIEWS.

A Handbook for Travellers in South Wales and its Borders, including the River Wye; with a Traveller's Map. London: John Murray, Albermarle-street. 1860.

Murray's handbooks are known everywhere. Wherever the traveller or tourist intends visiting a district or a country, he is sure in the first place to seek for one of Murray's Guides. It is fortunate for South Wales that, possessing so much geological interest, the authorship of Murray's handbook for that region has fallen into the hands of so good a geologist as our friend and correspondent, Dr. Bevan, who from his long residence there possesses also peculiar advantages for the task. The enormous development during the last twenty years of mining enterprise and the opening of new railways have made such material alterations in those parts that no one but a resident could never have accomplished a successful guide for the wanderer in search of the commercial, the useful, and the antique or the picturesque.

In the first three chapters on the physical features, geology, and manufactures, the student of our science has an admirably succinct account of all the principal matters of interest to him; while at page 29 all the "points of interest for the geologist" are specially picked out—like plums from the pudding—of the work, and handed to him in one luxurious dish.

Such perpetual and indefatigable ramblers as geologists invariably are—whenever they can be induced to look beyond their own dear dusty quarries at the social scenes and antiquarian relics that are everywhere to be met on the long, long roads which they with heavy loads so lightly travel,—they ought to be the "right men" for tourists' guides; and Dr. Bevan, who has undoubtedly kept his eyes open to all worth seeing, seems as much at home in the rest of his book as the traveller's companion as he undoubtedly is in the geological and physical descriptions of his district.

THE GEOLOGIST.

FEBRUARY, 1861.

ON BRITISH CARBONIFEROUS BRACHIOPODA.

By Thomas Davidson, Esq., F.R.S., F.G.S., etc

Four years have elapsed since I first commenced my researches among the Carboniferous Brachiopoda of Great Britain; and I should certainly by this time have completed my task, had not the unfortunate delay in the publication of the last two or three volumes of the Palæontographical Society induced me to undertake other work which would not require to lie printed and unpublished for upwards of one year and a half. My monograph cannot, consequently, be completed or entirely published for some time to come. perhaps a year or more; but as my researches in connection with the subject are almost ended, since the whole series of species at present known have been as carefully examined as my means and materials would permit, it may, perhaps, be as well that I should at once expose the results of my laborious enquiry, in the hope that by so doing some further assistance and advice may be proffered; which might enable me to make the monograph still more complete, and at the same time admit of my correcting in the concluding pages those unavoidable mistakes which have been commited during the interval which has elapsed since the commencement of its publication.

It may be thought by some while perusing the accompanying catalogue that the work to be gone through was but small in comparison with the time employed, but such would be an erroneous assumption, and a sad return to the numerous friends in England, Scotland, and Ireland, who have so zealously afforded their valuable and valued assistance, by incessantly ransacking the country in order to obtain every possible specimen that might assist and tend to complete the history of British Carboniferous species. Thousands and thousands of specimens have been assembled and transmitted to me by rail and post; and if I refrain from mentioning names it is because my full acknowledgements are recorded in my larger work, which, when complete, will compose a quarto volume, illustrated by some fifty or more plates. I may likewise mention that, with very few exceptions, I have had the great advantage of obtaining the loan of the original specimens from which each species had been first described, so that my comparisons have generally commenced with the type.

As a great many so-termed species have been rejected, it will be desirable to enter upon some few explanatory details.

At the time when I commenced my researches among the British Carboniferous Brachiopoda, some two hundred and fifty so-termed species had been recorded; but after a most searching investigation, I could not conscientiously make out more than about one hundred and eight; and even of this number some few should be located among the varieties, so that the determined species would not, at the present time, in all probability exceed about a hundred. In the second and improved edition of Prof. Morris's "Catalogue," published in 1854, one hundred and ninety three species are recorded, but of these about eighty-one only are retained in our lists.

It would be impossible in this short paper to enter into many statistical details; but we may mention that in 1836 Prof. Phillips enumerated about one hundred species, as having been found in England, and of which fifty-two are by us retained. Since the period of the publication of the "Geology of Yorkshire," many more species have been discovered, so that about ninety-seven are provisionally catalogued. The species from Scotland have been carefully examined, and from forty-nine to fifty retained. The Irish species have not, perhaps, been so completely studied as we might wish; and it is very possible and probable that the rocks of that island have afforded some few more than the seventy-three here admitted.

In 1844, Prof. M'Coy described two hundred and twenty-nine species, stated by him to have been found in Ireland, but figured only about sixty; and to this number several others were subsequently added by other naturalists, so that Mr. Kelly's Catalogue* comprises no less than two hundred and thirty-seven! If we compare Mr. Kelly's lists with the one here given a very great difference will be perceived; for notwithstanding all my good will and the liberal assistance of many Irish geologists, who assembled for my use every possible species, I have not been able, as already stated, to identify more than about seventy-three. Mr. Kelly's Catalogue comprises a great number of Silurian and Devonian species not known to me to occur in any Carboniferous rocks hitherto examined; and I may without hesitation assert that the larger number are, at any rate, due to incorrect identification; for the examination of many of the original specimens in Sir Richard Griffith's collections have convinced Prof. de Koninck, Mr. Salter, and myself of this important fact.

* "On the Localities of Fossils of the Carboniferous Limestone of Ireland:" Journal of the Geological Society of Dublin: 1855.

Many of M'Coy's so-termed Devonian species were not, however, to be found in any of the Irish collections, and their existence as Carboniferous fossils must, consequently, remain as "not proven," for the author of the "Synopsis," does not furnish us with any evidence as to the correctness of his determinations in the shape of illustrations.

Mr. Kelly, whose knowledge of Irish geology appears to equal, or even exceed that of any other man, expresses himself very averse to my rejecting so many Devonian species, said to have been found in his Carboniferous strata and localities, and considers I am not justified in passing judgment on the contents of between seventeen and eighteen thousand square miles of Carboniferous limestone said to exist in the sister island; but I do not presume to pass sentence upon any but those I am certain to be due to incorrect identification, and which have been so stamped by Prof. de Koninck, Mr. Salter, and myself, and at present existing in Sir R. Griffith's collection. All I wish to say with reference to the others is that, never having been able to procure the sight of a specimen, I am bound to state and believe that their existence is "not proven;" but I shall be delighted to admit and catalogue hereafter any of which a specimen or correct figure can be produced, and which on comparison will be found to agree with Silurian or Devonian types. In my monograph I have described those species only of which I have seen a specimen, or of whose existence I felt certain, and of which I was able to give a figure; for it appeared to me preferable to limit myself to what was certain, than to swell out my work by the introduction of a large amount of very doubtful matter. Mr. Kelly has informed me by letter that a large portion of the doubtful fossils were got in localities of the Calciferous slate, a band which lies next under the limestone; that out of some seventy not proven to me, because I have not seen specimens, twenty-two were obtained at Lisnapaste and Donegal; that in these localities there is a great variety; and that they occur in black soft shale, as soft and as easily decomposed by exposure to the atmosphere as any that occurs in the coal-measures; that a lump of this black shale exposed to sun and rain for one summer, would slake or fall to pieces; and he therefore supposes that by far the larger number of Lisnapaste specimens that were originally in Sir R. Griffith's collection were lost by their removal to the Great Exhibition held in Dublin, in 1852, as those tender shales would not bear the agitation of carriage, and consequently mouldered away into very small fragments. That there are six or eight other localities in the Calciferous slate in which similar shales occur with fossils, and that he finds upon looking over his lists that most of the Devonian species I object to were obtained in those localities. Along with Lisnapaste there is Larganmore, Bruckless, Kildress, (the red shales near Cookstown in the Old Red series), Bundoran, Malahide, Curragh, etc.

Having premised so much, we will now give a catalogue of all the species at present known to us from England, Scotland, and Ireland.

In my Collection	Catalogue of British Carboniferous Brachiopoda.	England.	Scotland.	Ireland.
*	*Terebratula sacculus*, Martin, Petrif. Derb., tab. xlvi., figs. 1, 2, 1809; Dav. Mon.,* pl. i., figs. 23, 24, 27, 29, 30, etc.	+	+	+
*	——— *hastata*, Sow. Min. Con., tab. ccccxlvi., figs. 2-3, 1824; Dav. Mon., pl. i., figs. 1-12; var. *virgoides*, M'Coy, var. *ficus*, M'Coy.	+	+	+
*	——— *Gillingensis*, Dav. Mon., pl. i., figs. 18-20; pl. iii., fig. i., 1847.	+		
*	——— *vesicularis*, De Koninck, An. Foss. de la Belgique, sup., pl. lvi., fig. 10, 1851; Dav. Mon., pl. xxv., figs. 1-7, = *Seminula seminula*, M'Coy.	+	+	
*	*Athyris Roysii*, L'Eveillé, Mémoires de la Soc. Geol. de France, vol. ii., pl. ii., figs. 18-20, 1835; Dav. Mon., pl. xviii., figs. 1-11, = *T. fimbriata*, Phil., = *T. glabristria*, Phil., = *T. depressa*, M'Coy.	+	+	+
*	——— *expansa*, Phil., Geol. York, vol. ii., pl. x., fig. 18, 1836; Dav. Mon., pl. xvi., figs. 14-16 and 18; pl. xvii., figs. 1-5.	+		
*	——— *lamellosa*, L'Eveillé, Mem. de la Soc. Geol. de France, vol. ii., pl., figs. 21-23, 1855; Dav., pl. xvi., fig. 1, and pl. xvii., fig. 6, = *T. squamosa*, Phillips.	+		+
*	——— *plano-sulcata*, Phillips' Geol. York, vol. ii., pl. x., fig. 15, 1836; and Dav. Mon., pl. xvi., figs. 2-13, 15, = *A. paradoxa*, M'Coy, = *A. obtusa*, M'Coy, = *T. oblonga*, Sow.	+	+	+
*	——— *globularis*, Phillip's Geol. of York., vol. ii., pl. x., fig. 22, 1836; and Dav. Mon., pl. xvii, figs. 15-18.	+		
*	——— *ambigua*, Sow., Min. Con., pl. ccclxxvi., 1822; and Dav. Mon., pl. xv., figs. 15-23, = *T. sublobata*, Portlock, = *T. pentaedra*, Phillips.	+	+	+
*	——— *subtilita*, Hall. Howard Stansbury's Exploration of the Valley of the Great Salt Lake of Utah, pl. iv., figs. 1-6, 1852; Dav. Mon., pl. i., fig. 21-22, pl. xvii., figs. 8-10.	+		+
*	——— *squamigera*, De Kon., Desc. An. Foss. de la Belgique, sup., pl. lvi., fig. 9, 1851; and Dav. Mon., pl. xviii., figs. 12, 13.	+		+
*	*Retzia radialis*, Phillips' Geol. of York., vol. ii., pl. xii., figs. 10, 11, 1836; Dav. Mon., pl. xvii., figs. 19-21.	+	+	
	——— *ulotrix*, De Kon., Desc. des Animaux Foss. de la Belgique, pl. xix., fig. 5, 1843; and Dav. Mon. Carb., pl. xviii., figs. 14, 15.	+		
*	*Spirifera striata*, Martin, Petrif. Derb., t. xxiii., 1809; Dav. Mon., pl. ii., figs. 12-21, and pl. iii., figs. 2-6, = *T. spirifera*, Lamk., = *Sp. attenuata*, Sow., = *S. princeps*, M'Coy, = *S. clathrata*, M'Coy, = *S. condor*, D'Orb., = *S. triplicatus*, Hall, *Logani*, Hall.	+		+
*	——— *Mosquensis*, Fischer, Programme sur la Choristites, 1825; Dav. Mon., pl. iv., figs. 13, 14, = *C. Sowerbii* and *Kleinii*, Fischer, = *S. choristites*, V. Buch, = *incisa*, Goldfuss, = *S. priscus*, Eichwald.	+		+

* Mon. refers to my Monograph of Carb. Brachiopoda, published by the Palæontographical Society. S. Mon. refers to my Monograph of Scottish Carboniferous Brachiopoda.

In my Collection.	Catalogue of British Carboniferous Brachiopoda.	England.	Scotland.	Ireland.
*	*Spirifera humerosa*, Phil., Geol. York., pl. xi., fig. 8, 1836, and Dav. Mon., pl. iv., figs. 15, 16.	+		
*	——— *duplicicosta*, Phillips' Geol. York., vol. ii., pl. x., fig. 1, 1836; and Dav., pl. iii., figs. 7-10, pl. iv., figs. 3-11, = *S. furcata*, M'Coy, = *S. fasciculata*, M'Coy.	+	+	+
*	——— *planata*, Phillips' Geol. York, pl. x., fig. 3, 1836; and Dav. Mon., pl. vii., figs. 25, 36.	+		
*	——— *triangularis*, Martin, Petrif. Derb., pl. xxxvi., fig. 2, 1809; and Dav. Mon., pl. v., figs. 16-24.	+		+
*	——— *trigonalis*, Martin, Petrif. Derb., pl. xxxvi., fig. 1, 1809; and Dav. Mon., pl. v., figs. 25-35.	+	+	
*	——— *bisulcata*, Sow., Min. Con., pl. ccccxciv., figs. 1, 2, 1825; and Dav. Mon., pl. iv., figs. 1, 2, pl. v., fig. 1, pl. vi., figs. 1-22, pl. vii., figs. 1-4, 7-16, = *S. semicircularis*, Phillips, = *S. calcarata*, M'Coy (not Sow.), = *S. transiens*, M'Coy, = *S. grandicosta* (?), M'Coy, = *S. crassa*, De Kon., = *S. planicosta*, M'Coy, etc.	+	+	+
*	——— *convoluta*, Phillips' Geol. of York., vol. ii., pl. ix., fig. 7, 1836; and Dav. Mon., pl. v., figs. 9-15.	+		
*	——— *rhomboidea*, Phillips' Geol. of York., vol. ii., pl. ix., figs. 8-9, 1836; and Dav., pl. v., figs. 2-8.	+		+
	——— *fusiformis*, Phillips' Geol. of York., pl. ix., figs. 10, 11, 1836; Dav. Mon., pl. xiii., fig. 15. This is a doubtful species.	+		
	——— *mesogonia*, M'Coy, Synopsis, pl. xxii., fig. 13, 1844; and Dav. Mon., pl. vii., fig. 24.			+
*	——— *distans*, Sow., Min. Con., pl. ccccxciv., fig. 3, 1825; and Dav. Mon., pl. viii., figs. 1-17 and 18 (?), = *S. bicarinata*, M'Coy.	+		+
*	——— *cuspidata*, Martin, Trans. Lin. Soc., vol. iv., pl. iii., figs. 1-4, 1796; Dav. Mon., pl. viii., figs. 19-24, pl. ix., figs. 1, 2, = *S. subconicus*, Martin.	+		+
*	——— *triradialis*, Phil. Geol. York., vol. ii., pl. x., fig. 7, 1836; Dav. Mon., pl. ix., figs. 4-12, = *S. trisulcata*, Phil., = *S. sexradialis*, Phil.	+		+
	——— *Reedii*, Dav. Mon., pl. v., figs. 40, 47, 1857. Doubtful species.	+		
*	——— *pinguis*, Sow., Min. Con., pl. cclxxi., 1820; and Dav., pl. x., figs. 1-12; = *S. rotundata*, Sow. (not Martin), = *S. sub-rotundata*, M'Coy.	+	+	+
*	——— *ovalis*, Phillips' Geol. York., vol. ii., pl. x., fig. 5, 1836; Dav. Mon., pl. ix., figs. 20-26, = *S. exarata*, Fleming, = *hemisphærica*, M,Coy.	+	+	+
*	——— *integricosta*, Phillips' Geol. York., pl. x., fig. 2, 1836; Dav., pl. ix., figs. 13-19, = *S. rotundata*, Martin (?), = *paucicosta*, M'Coy (?).	+		
*	——— *glabra*, Martin, Petrif. Derb., pl. xlviii., figs. 9, 10, 1809; Dav. Mon., pl. xi., figs. 1-9, and pl. xii., figs. 1-5, 11, 12, = *S. obtusa* and *S. oblata*, Sow., = *S. linguifera* and *S. decora*, Phillips.	+	+	+
*	——— *rhomboidalis*, M'Coy, Synopsis, pl. xxii., fig. 11, 1844; and Dav. Mon., pl. xii., figs. 6-7.			+

In my Collection.	Catalogue of British Carboniferous Brachiopoda.	England.	Scotland.	Ireland.
*	*Spirifera Urii*, Fleming, Br. An., p. 376, 1828; and Dav. Mon., pl. xii., figs. 13, 14, and Dav. Sc. Mon., pl. i.*, fig. 30, = *unguiculus*, Phil., = *clannyana*, Kon.	+	+	+
*	——— *Carlukiensis*, Dav. Mon., pl. xiii., fig. 14, 1857.		+	
*	——— *lineata*, Martin, Petrif. Derb., pl. xxxvi., fig. 3, 1809; Dav. Mon., pl. xiii., figs. 4-13, Sc. Mon., pl. i.*, fig. 31, = *M. strigocephaloides*, M'Coy, = *S. reticulata*, = *S. mesoloba*, Phil., = *S. imbricata*, Sow.	+	+	+
*	——— *elliptica*, Phil. Geol. York., pl. x., fig. 16, 1836; Dav. Mon., pl xiii., figs. 1-3.	+		+
	Spiriferina laminosa, M'Coy, Synopsis, pl. xxi., fig. 4, 1844; and Dav. Mon., pl. vii., figs. 17, 22, = *S. tricornis*, De Kon.	+	+	+
*	——— *cristata*, var. *octoplicata*, Sow., Min. Con., pl. dlxii., figs. 2-4, 1827; and Dav. Mon., pl. vii., figs. 37-47, 60, 61, = *Sp. partita*, Portlock.	+	+	+
	——— *minima*, Sow., Min. Con., tab. ccclxxvii., fig. 1, 1822; Dav. Mon., pl. vii., figs. 56-59. A very doubtful species.	+		
*	——— *insculpta*, Phil., Geol. York., pl. ix., figs. 2, 3 1836; Dav., pl. vii., figs. 48, 55, = *S. quinqueloba*. M'Coy.	+	+	+
*	*Cyrtina septosa*, Phillips' Geol. York., vol. ii., pl. ix., fig. 7, 1836; Dav. Mon., pl. xiv., figs. 1-10, pl. xv., figs. 1, 2.	+		
	——— *dorsata*, M'Coy, Synopsis, pl. xxii., fig. 14, 1844; Dav. Mon., pl. xv., figs. 3, 4.			+
*	——— *carbonaria*, M'Coy, Br. Pal. Fossils, pl. iii.D, figs. 12-18, 1855; Dav. Mon., pl. xv., figs. 5-14.	+		
*	*Rhynchonella reniformis*, Sow., Min. Con., pl. ccccxcvi., figs. 1-4, 1825; and Dav. Mon., pl. 19., figs. 1-7.	+		+
*	——— *cordiformis*, Sow., Min. Con., tab. ccccxcv., fig. 2, 1825; and Dav. Carb. Mon., pl. xix., figs. 8-10. A doubtful species.	+		+
*	——— *acuminata*, Martin, Petrif. Derb., pl. xxxii., figs. 7, 8, and pl. xxxiii., figs. 5, 6, 1809; and Dav. Mon., pl. xx., figs. 1-13, pl. xxi., figs. 1-20, = *T. platyloba*, Sow., = *T. mesogonia*, Phil.	+		+
*	——— *pleurodon*, Phillips' Geol. of York., vol. ii., pl. xii., figs. 25-30, 1836; and Dav. Mon., pl. xxiii., figs. 1-20, = *T. Mantiæ*, Sow., = *T. ventilabrum*, Phillips, = *T. pentatoma*, De Kon., = *T. triplex*, M'Coy, = *Davreuxiana*, De Kon.	+	+	+
*	——— *flexistria*, Phillips' Geol. York., pl. xii., figs. 33, 34, 1836; and Dav. Mon., pl. xxiv., figs. 1-8, = *T. tumida*, Phillips, = *H. heteroptycha*, M'Coy.	+		+
*	——— *pugnus*, Martin, Petrif. Derb., tab. xxii., figs. 4-5, 1809; and Dav. Mon., pl. xxii., figs. 1-15, = *T. sulcirostris*, Phil., = *A. laticlira*, M'Coy.	+	+	+
*	——— *angulata*, Linnæus, Syst. Nat., p. 1154, 1767; and Dav. Mon., pl. xix., figs. 11-16.	+		+
	——— *trilatera*, De Kon., Animaux Foss. de la Belgique, pl. xix., fig. 7, 1843; and Dav. Mon., pl. xxiv. fig. 23-26.	+		

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	Rhynchonella ? gregaria, M'Coy, Synopsis, pl. xxii., fig. 18, 1844; and Dav. Carb. Mon., pl. xv., figs. 27, 28. Not sufficiently studied.			+
	{ *Rh. nana*, M'Coy, Synopsis, pl. xxii., fig. 19, 1844; Ireland.			
	{ *R. semisulcata*, M'Coy, Synopsis, pl. xxii., fig. 15; Ireland: doubtful species ?.			
*	*Camarophoria crumena*, Martin, Petrif. Derb., pl. xxxvi., fig. 4, 1809; and Dav. Mon., pl. xxv., figs. 3, 9, = *C. Schlotheimi*, V. Buch.	+	+	+
	Var. ? *T. proava*, Phil., Geol. of York., vol. ii., pl. xii., fig. 37, 1836; and Dav. Mon., pl. xxv., fig. 10; England.			
*	——— *globulina*, Phil., Ency. Met., vol. iv., pl. iii., fig. 3, 1834; Dav. Mon., pl. xxiv., figs. 9-22; *T rhomboidea*, Phil., = *T. seminula*, Phil., = *H. longa*, M'Coy ?.	+		
	——— *isorhyncha*, M'Coy, Synopsis, pl. xviii., fig. 8, 1844; and Dav. Mon., pl. xxv., figs. 1, 2. Not sufficiently studied, from want of material.			+
	——— ? *laticlira*, M'Coy, Br. Pal. Foss., pl. iii.D, figs. 20, 21, 1855; Dav. Mon., pl. xxv., figs. 11, 12. Not sufficiently studied, from want of material.	+		
*	*Strophomena (rhomboidalis)* var. *analoga*, Phillips' Geol. of York., pl. vii., fig. 10, 1836; Dav. Mon., pl. xxviii., figs. 1, 13, = *P. depressa*, Sow., = *P. rugosa*, His., = *C. quadrangularis*, Steininger, = *L. tenuistriata*, Sow., = *L. distorta*, Sow., = *L. nodulosa*, Phil., = *L. multirugata*, M'Coy.	+	+	+
*	*Streptorhynchus crenistria*, Phillips' Geol. York., pl. ix., fig. 6, 1836; and Dav. Mon., pl. xxvi., fig. 1, pl. xxvii., figs. 1-5, and 10 ?, pl. xxx., figs. 14-16, = *S. senilis*, Phil., = *Lept. anomala*, J. de C. Sow., Min. Con., tab. dcxv., fig. 1*b*, = *O. umbraculum*, var. Portlock, = *O. Bechei*, M'Coy, = *O. comata*, M'Coy, = *O. caduca*, M'Coy, = *O. keokuck* and *O. robusta*, Hall.	+	+	+
	* Var. A. *T. arachnoidea*, Phillips' Geol. of York., vol. ii., pl. xi., fig. 4, 1836; Dav. Mon., pl. xxv., figs. 19-21, pl. xxvi., figs. 2-4 (lower fig.) 5,6, = *O. Portlockiana*, Semenow; England, Scotland, Ireland.			
	Var. B. *S. Kellii*, M'Coy, Synopsis, pl. xxii., fig. 4, 1844; Dav. Mon., pl. xxvii., fig. 8; England, Scotland, Ireland.			
	Var. C. *S. cylindrica*, M'Coy, Synopsis, pl. xxii., fig. 1, 1844; and Dav., pl. xxvii., fig. 9; Ireland.			
	* Var. D. *S. radialis*, Phillips' Geol. York., pl. xi., fig. 5, 1836; Dav. Mon., pl. xxv., figs. 16-18; England, Scotland, Ireland.			
*	*Orthis resupinata*, Martin, Petrif. Derb., pl. xlix., figs. 13, 14, 1809; Dav. Mon., pl. xxix., figs. 1-6, and pl. xxx., figs. 1-5, = *O. connivens*, Phil., = *O. gibbera*, Portlock, = *O. latissima*, M'Coy.	+	+	+
*	——— *Michelini*, L'Eveillé, Mem. Soc. Geol. France, vol. ii., figs. 14-17, 1835; Dav. Mon., pl. xxx., figs. 6-12, = *S.*	+	+	+

In my Collection.	Catalogue of British Carboniferous Brachiopoda.	England.	Scotland.	Ireland.
	filaria, Phil., = *O. circularis*, M'Coy, = *O. divaricata*, M'Coy.			
*	*Orthis Keyserlingiana*, De Kon., An. Foss. de la Belgique, pl. xiii., fig. 12, 1843; Dav. Mon., pl. xxviii., fig. 14.	+		
*	——— ? *antiquata*, Phil., Geol. York, tab. xi., fig 20, 1836; and Dav. Mon., pl. xxviii., fig. 15. Not sufficiently studied from want of material.	+		
*	*Productus giganteus*, Martin, Petrif. Derb., pl. xv., fig. 1, 1809; and Dav. Mon., pl. xxxvii., xxxviii., xxxix., and xl., = *A. crassa*, Martin, = *P. aurita*, Phil., *P. Edelburgensis*, Phil., *P. maxima*, M'Coy, = *P. hemisphæricus*, part Sow.	+	+	+
*	——— *latissimus*, Sow., Min. Con., tab. cccxxx., 1822; and Dav. Mon. Scottish Brach., pl. ii., figs. 8, 9; and Mon., pl. xxxv., figs. 1-4.	+	+	+
*	——— *Cora*, D'Orb., Palæont. du Voyage dans l'Amerique Meridionale, p. 58, pl. v., figs. 8-10, 1842: De Koninck, Mon. du Genre Productus, pl. iv., fig. 4, pl. v., fig. 2, = *P. corrugata*, M'Coy; Dav. Mon., pl. xxxvi., fig. 4.	+	+	+
*	——— *semireticulatus*, Martin, Petrif. Derb., pl. xxxii., figs. 1, 2, pl. xxxiii., fig. 4, 1809; Dav. Mon. Scottish Brach., pl. iv., figs. 1-12; and Mon., pl. xliii., figs. 1-6, and pl. xliv., figs. 1-3, = *A. antiquata*, Martin, = *P. concinna*, Sow., = *P. jugilis*, Phil., = *P. scotica*, Sow., = *P. sulcata*, Sow., = *P. flexistria*, M'Coy (according to Prof. De Koninck), *A. producta*, Parkinson. Var. *Martini*, Sow. Min. Con., pl. cccxvii, figs. 2-4; Dav. Mon., pl. xliii., figs. 7-11; England, Scotland, Ireland.	+	+	+
*	——— *longispinus*, Sow., Min. Con., tab. lxviii., fig. 1, 1814; Dav. Scottish Carb. Mon., pl. ii., figs. 10-19, and Mon., pl. xxxv., figs. 5-17 = *P. Flemingii*, = *P. lobata*, = *P. spinosa*, Sow., = *P. setosa*, Phil.	+	+	+
*	——— *humerosus*, Sow., Min. Con., tab. cccxxii., 1822; Dav. Mon., pl. xxxvi., fig. 1-3.	+		
*	——— *striatus*, Fischer, Oryct. du Gouv. de Moscou, pl xix., fig. 1, 1830 and 1837; Dav. Mon., pl. xxxiv., figs. 1-5, = *P. inflata*, Phil., = *P. limæformis*, V. Buch, *L. anomala*, J. de C. Sow., Min. Con., tab. dcxv., fig. 1, *a*, *c*, *d*, (not *b*).	+		
*	——— *margaritaceus*, Phillips, Geol. York., pl. viii., fig. 8, 1836; Dav. Mon., pl. xliv., figs. 5-8, = *P. pectinoides*, Phil.	+		+
*	——— *proboscideus*, De Vern., Bulletin de la Soc. Geol. de France, vol. xi., pl. iii., fig. 3, 1840; Dav. Mon., pl xxxiii., figs. 1-4.	+		
*	——— *ermineus*, De Koninck, Desc. des Animaux Foss. de la Belgique, pl. x., fig. 5, 1843; and Dav. Mon., pl. xxxiii., fig. 5.	+		
*	——— *sinuatus* (*Lept. sp.*) De Koninck, An. Foss. de la Belgique, sup., t. lvi., fig. 2; and Dav. Mon., pl. xxxiii., figs. 8-11.	+	+	

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*	——— *costatus*, Sow., Min. Con., pl. dlx., fig. 1, 1827, = *P. costellatus*, M'Coy ; Dav. Mon., pl. xxxii., figs. 2-9.	+	+	+
*	——— *muricatus*, Phil., Geol. York, vol. ii., pl. viii., fig. 3, 1836; Dav. Scottish Carb. Mon., pl. ii., fig. 25, pl. iv., fig. 25 ; England, Scotland; Dav. Mon., pl. xxx., figs. 10-14.			
	——— *carbonarius*, De Kon., Desc. des An. Foss. de la Belgique. pl. xii. *bis*, fig. 1, 1843 ; and Dav. Mon., pl. xxxiv., fig. 6.		+	
*	——— *undatus*, Defrance, Dic. des Sc. Nat., vol. xliii., p. 354, 1826 ; De Kon., Desc. des An. Foss. de la Belgique, pl. xii., fig. 2 ; Dav. Mon., pl. xxxiv., figs. 7-12, = *P. tortilis*, M'Coy ?.	+	+	+
*	——— *arcuarius*, De Kon., Desc. des Animaux Foss. de la Belgique, pl. xii., fig. 10, 1843 ; Dav. Mon., pl. xxxiv., fig. 17.	+		
*	——— *aculeatus*, Martin, Petrif. Derb., pl. xxxvii., figs. 9, 10, 1809 ; and Dav. Mon., pl. xxxiii., fig. 16-20, = *P. laxispina*, Phil.	+	+	+
*	——— *Youngianus*, Dav. Mon. of Scottish Carb. Brach., pl. ii., fig. 26, and pl. v., fig. 7, 1860 ; and Mon., pl. xxxiii., figs. 21-23.	+	+	+
*	——— *Keyserlingianus*, De Kon., Desc. des An. Foss. de la Belgique, pl. x., fig. 8, 1843 ; Dav. Mon., pl. xxxiv., figs. 15, 16.	+		
*	——— *Wrightii*, Dav., Carb. Mon., pl. xxxiii., figs. 6, 7, 1861.			+
*	——— *tessellatus*, De Kon., Desc. des An. Foss. de la Belgique, pl. ix., fig. 2, 1843 ; and Dav. Mon., pl. xxxiii., figs. 24, 25. and pl. xxxiv., fig. 14.	+		+
*	——— *plicatilis*, Sow., Min. Con., tab. cccclix., fig. 2 ; and Dav. Mon., pl. xxxi., figs. 3-5.	+	+	+
*	——— *mesolobus*, Phillips' Geol. of York., vol. ii., pl. vii., figs. 12, 13, 1836 ; Dav. Mon., pl. xxxi., figs. 6-9.	+	+	+
	——— *sub-lævis*, De Kon., Desc. des An. Foss. de la Belgique, pl. x., fig. 1, 1843 ; Dav. Mon., pl. xxxi., figs. 1, 2.	+		
*	——— *Christiani*, De Kon., Monographie du Genre Productus, pl. xvii., fig. 3, 1847 ; Dav. Mon., pl. xxxii., fig. 1.	+		
*	——— *scabriculus*, Martin, Petrif. Derb., pl. xxxvi., fig. 5, 1809 ; Dav. Scottish Carb. Mon., pl. iv., fig. 18, and pl. v., fig. 6, Mon., pl. xlii., figs. 5-8 ; = *P. quincuncialis*, Phillips.	+	+	+
*	——— *pustulosus*, Phillips' Geol. of York., vol. ii., pl. vii., fig. 15, 1836 ; Dav. Mon., pl. xli., figs. 1-6, and pl. xlii., figs. 1-4, = *P. ovalis*, Phil., = *P. rugatus*, Phil., = *P. pyxidiformis*, De Kon.	+	+	+
*	——— *spinulosus*, Sow., Min. Con., tab. lxviii., fig. 3, 1814 ; Dav. Mon., pl. xxxiv., figs. 18, 20, = *P. granulosus*, Phillips.	+	+	+
*	——— *punctatus*, Martin, Petrif. Derb., pl. xxxvii., fig. 6, 1809 ; Dav. Scottish Carb. Br., pl. iv., figs. 20, 22, Mon., pl. xliv., figs. 9-18, = *P. elegans*, = *P. laciniatus*, M'Coy	+	+	+
*	——— *fimbriatus*, Sow., Min. Con., tab. ccccclix, fig. 1, 1823 ; and Dav. Mon., pl. xxxiii., figs. 12-15.	+	+	+

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*	*Chonetes papilionacea*, Phil., Geol. of York., pl. xi., fig. 2, 1836, Dav. Mon., pl. xlv., figs. 3-6, = *Lept. multidentata*, M'Coy, *C. papyracea*, M,Coy.	+		+
*	——— *Dalmaniana*, De. Kon., Desc. des Animaux Foss. de la Belgique, pl. xiii., fig. 3, and pl. xiii. *bis*, fig 2, 1843.	+		
	——— *comoides*, Sow., M. C., tab. ccccxxix., 1816.	+		+
*	——— *Buchiana*, De Kon., Desc. des An. Foss. de la Belgique, pl. xiii., fig. 1, 1843; and Dav. Scottish Carb. Mon., pl. ii., fig. 1.	+	+	+
?	{ Var. *crassistria*, M'Coy, Synopsis, pl. xx., fig. 10, 1844; and British Carb. Foss., pl. iii.H, fig. 5; England, Ireland.			
	Var. *tuberculata* ?, M'Coy, Synopsis, pl. xx., fig. 5, 1844; Ireland. }			
	Var. *bifurcata*, Dav. Mon. Settle, Yorkshire.			
*	——— *Hardrensis*, Phil., Figs. and Descr. of the Pal. Foss. of Cornwall and West Somerset, pl. ix., fig. 184, 1841; and Dav. Mon. of Scottish Carb. Br., pl. ii., fig. 2-7, = *C.* (*Lept.*) *sub-minima* and *C.* (*Lept.*) *gibberula* M'Coy.	+	+	+
	Doubtful species, varieties, or synonyms.			
	C. volva, M'Coy, Synopsis, tab. xviii., fig. 14; Ireland.			
	C. (*Orthis*) *sulcata*, M'Coy, ,, ,, ,, 6; ,,			
	C. (*Lept.*) *perlata* ,, ,, ,, 9; ,,			
	C. (*Lept.*) *serrata* ,, ,, ,, 10; ,,			
	C. polita, M'Coy, Br. Pal. Foss., t. iiiD., fig. 30; England.			
	C. Laguessiana, De Kon., An. Foss. de la Belgique, tab. xii. *bis*, fig. 4; England. ?			
*	*Crania quadrata*, M'Coy, Synopsis, pl. xx., fig. 1, 1844; and Dav. Scottish Carb. Mon., pl. v., fig. 12-21.	+	+	+
	——— ? *Rychholtiana*, De Kon., Animaux Foss. de la Belgique, pl. xxiii., fig. 5, 1843, = *C. vescicularis*, M'Coy, Synopsis, pl. xx., fig. 3, 1844.	+		+
	——— ? *trigonalis*, M'Coy, Synopsis, pl. xx., fig. ii, 1844.			+
*	*Discina nitida*, Phillips' Geol. of York., vol. ii., pl. xi., figs. 10-13, 1836; and Dav. Scottish Carb. Mon., pl. v., figs. 22-29, 1860, = *O. cincta*, Portlock, = *D. bulla*, M'Coy.	+	+	+
	——— *Davreuxiana*, De Kon., An. Foss. de la Belgique, pl. xxi., fig. 4, 1843.			+
*	*Lingula squamiformis*, Phillips' Geol. York, vol. ii., pl. xi., fig. 14, 1836; and Dav. Scottish Carb. Mon., pl. v., fig. 30-35, 1860, = *L. marginata*, Phil., *L. Portlockii*, M'Coy.	+	+	+
*	——— *mytiloides*, Sow., Min. Con., tab. xix., fig. 1, 2, 1813; Dav. Scottish Carb. Mon., pl. v., figs. 38-43, = *L. elliptica*, Phil., = *L. parallela*, Phil.	+	+	+
*	——— *Credneri*, Genitz, Versteinerungen des Zechsteingebirges, pl. iv., figs. 23, 29, 1848.	+		
*	——— *Scotica*, Dav. Scottish Carb. Br., pl. v., figs. 36, 37, 1860.		+	
		97	51	73

Total to Great Britain, 107 species. ?

OBSERVATIONS.

Terebratula.—Four species have been provisionally admitted; but as they appear all so closely connected by intermediate or passage shapes, it may still remain a question whether they in reality are more than varieties or modifications in shape of a single species? It has often been said and thought that *T. hastata* was no more than an elongated full-grown condition of Martin's *T. sacculus*, and it is at times hardly possible to distinguish certain examples of *T. Gillingensis* and *T. vesicularis* from Martin's shell. *T. virgoides* has been supposed to be distinct from *T. hastata*; but after a lengthened examination of the original specimen figured in the "Synopsis," and another from the same locality (Windmill, in Ireland), I could not make up my mind to separate it from *T. hastata*, to some specimens of which it bears much resemblance. *T. vesicularis* is a very variable shell; for, while some specimens present the deep triundate or triplicated dorsal valve, or frontal margin, in the greater number of individuals this is very slightly marked, and even absent. *T. vesicularis* was for long believed to be a small shell not exceeding seven lines in length, but some large examples recently discovered at Bowertrapping, in Scotland, have exceeded an inch in length.

It would, therefore, not be impossible that all the British Carboniferous Terebratulæ hitherto discovered may, perhaps, belong to a single species, capable of assuming different shapes, and not presenting a greater extent of modification than what we find in the *T. Australis* as well as in many other recent and fossil species. Are not the Jurassic *Ter. plicata* and *T. fimbriata* entirely smooth up to a certain age, and indeed often so to an advanced age, when they suddenly, or by degrees, becomes more or less regularly or irregulary plicated during the remaining period of their growth? For the present, however, and until our ideas as to the *absolute necessity* of enlarging the circle or range of variation to be permitted to a species be admitted and understood, the four species of Terebratula recorded may be provisionally retained.

Athyris or *Spirigera.*—In external shape the species of this genus approach more to *Terebratula* than to any other, and therefore in a good or natural arrangement should preceed *Spirifer*. Of *Athyris*, eight species have been provisionally retained from among the many synonyms, while the value of *A. globularis* and *A. squamigera* may still require confirmation, for of both these shells the material at my command has been very scanty; and it is even uncertain whether the identification with *A. squamigera* (de Koninck) be correct.

Of *Retzia* there appears to exist two species, of which *R. radialis* is both the less rare and most variable shell; for in some localities it appears to occur as a small race with slender ribs, which in other localities individuals twice the size with stronger ribs are prevalent. Of *Retzia ulotrix* I am acquainted with but two or three British examples, so that a search for more would be very desirable.

Spirifera.—Twenty-five species (?) are here provisionally retained, for the reasons already given, viz., the want of sufficiently certain connecting links; but it is highly probable that with time and study some few of these may be dispensed with, or retained as mere varieties. Martin's *Spirifera striata* is the largest and most typical form of the genus, and must therefore always be considered a good species; but I would recommend a further study of *Sp. Mosquensis*, *Sp. humerosa*, and *Sp. duplicicosta*, in order to ascertain whether they are also good species, or modifications of *Sp. striata*; for I confess that many examples of the three last-mentioned species could be but doubtfully separated from Martin's shell. *Sp. planata* and *Sp. triangularis* appear to be good species. *Sp. bisulcata* has varied considerably in form; and I am quite disposed to agree with my friend, Prof. de Koninck, in the idea that *Sp. crassa* and *Sp. grandicostata* are simple modifications in the shape of *Sp. bisulcata*. It is even a question requiring further examination whether *Sp. trigonalis* should be considered separate; and, although *Sp. convoluta* is a wonderfully transverse and curious shell, I am not yet quite satisfied that it is not likewise related to *S. bisulcata*. *Sp. rhomboidea*, Phill., is still an uncertain form, of which my material has been too scanty; and as I am uncertain whether I was justified when uniting it to *Sp. convoluta*, it will be better for the present, at least, to retain it as separate. Of *Sp. fusiformis* but a single fragmentary specimen has been hitherto discovered, so that its specific claims cannot be definitely admitted.

Sp. mesogonia is also a rare shell, for I have never seen of it more than the figure in the "Synopsis;" and Irish geologists and collectors will do well in searching for more specimens. *Sp. cuspidata* is a good species, distinct from *Sp. distans*; to which last I would unite *Sp. bicarinata*, which M'Coy established on a single imperfect specimen from Cork, in the possession of Dr. Haimes, and which has much of the appearance assumed by certain examples of *S. distans*. *Sp. triradialis* is a good species, but very variable in the arrangement and number of its ribs; and of which the *Sp. trisulcosa* and *Sp. serradialis* of Phillips are evident modifications. *Sp. Reedii* must be looked upon as a doubtful species, requiring, perhaps, to be hereafter expunged; my material was very scanty, and I have since had doubts as to its validity. *Sp. pinguis* is a good but variable species, into which should perhaps be combined, as varieties, *Sp. ovalis* and *Sp. integricosta*, for many intermediate shapes are often found, so much so that the palæontologist is often puzzled how to determine with which of the three they should be located; but, the larger number of specimens being tolerably distinct and easily recognisable, we may be excused for provisionally retaining the three denominations.

Sp. glabra is another excellent species, or a type round which are clustered many modifications not sufficiently marked to constitute separate species; for, although the typical form of *Sp. glabra* possessed smooth valves, it is not uncommon to find in other examples faint indications of lateral plication, or obscurely flattened or slightly rounded ribs, the fold and sinus remaining always smooth. These modifications lead us gradually to *Sp. rhomboidalis*, which might also be nothing more than a variety of *Sp. glabra*. I merely express here on this and other questions the results of my own impressions or personal observations, which may be more or less erroneous. *Sp. Urii* is a good little species, which I believe to be a recurrent form of the Devonian, and present also in the Permian strata, notwithstanding Prof. King's assertion to the contrary.

Sp. Carlukiensis, as far as I know, is also distinct: while *Sp. lineata* is another excellent species, but exceedingly variable in shape and sculpture; at one time I felt disposed to unite with it *Sp. elliptica;* but having subsequently felt somewhat uncertain, have since preferred to consider it provisionally separate.

Sp. Urii, *Sp. lineata*, and I believe *Sp. elliptica* had their surfaces closely covered with numerous small spines, and it is possible that other forms were so invested.

Spiriferina.—Of this subgenus three species only appear to have been properly distinguished, viz., *Sp. laminosa*, *Sp. insculpta*, and *Sp. cristata, var. octoplicata*. *Sp. minima* has been established on one or two specimens still very doubtfully characterized; as all my efforts have been unsuccessful in the endeavour to obtain more, I consider the name hardly worth retaining.

Cyrtina.—Of this subgenus two good species appear to exist, viz., *C. septosa* and *C. carbonaria*, a third, *C. dorsata*, is somewhat doubtfully determined, on account of the imperfect material at my command, which consisted of two fragments only from the Carboniferous limestone of Cork, in Ireland. It would, therefore, be very desirable that geologists in that locality should have a search for better specimens.

Rhynchonella.—Nine species are provisionally retained; but the claims of *Rh. cordiformis* have not been satisfactorily established; and of *Rhynchonella ? gregaria* but two imperfect valves have come under my examination. *Rhynchonella ? trilatera* appears to be also a very rare species, for I am acquainted with only a very few specimens from Derbyshire, in the British Museum, and in that of the School of Mines: it appears also to be a rare shell in Belgium. *Rh.? nana* and *Rh. semisulcata* are by far too doubtful to deserve more than a passing notice; and it is deeply to be regretted that palæontologists can bring themselves to fabricate *species* on such insufficient and imperfect material, adding only confusion where such should be carefully avoided.

Camarophoria. — Four species have been recorded; but more abundant and better material with reference to *C. isorhyncha* and *C. lateralis* must be obtained before these can be definitely adopted. Of the first I am acquainted with but a single imperfect example: of the second, with those only in the Cambridge Museum.

C. Crumena, Martin, is a well made out species, and evidently the same as that from the Permian rocks known under the designation of *C. Schlotheimi;* and although I consider myself justified in referring *Terebratula rhomboidea* and *T. seminula* of Phillips to the same author's *C. globulina*, the matter may perhaps demand some further examination.

Strophomena analoga.—This species appears to have been recurrent from the Silurian and Devonian periods; and although certain small differences of secondary value may be observed in the *St. rhomboidalis* (Silurian) and the *St. analoga;* they are both constructed on a similar model, and appear to be varieties of a single species. As however some small differences in detail may be noticed in the Carboniferous shell, the term *analoga* should perhaps be retained, if not as a specific, at least as a varietal designation.

Streptorhyncus crenistria, Phillips. Many so-termed species have been fabricated out of varieties or variations in the shape of this very variable shell; and of which the larger number (if not all) are undoubted synonyms. Three or four of these may however still demand further examination and study, so as to determine whether they should be considered more than varieties of *S. crenistria?* I have therefore provisionally retained the following designations, *S. arachnoidea*, *S. Kellii*, *S. cylindrica*, and *S. radialis*, as named varieties of *S. crenistria*. Of *S. cylindrica* I have never seen any other than the type, and although *S. Kellii* is stated to be plentiful in certain Irish localities, but three specimens in all have passed under my observation. Prof. Phillips informs me that he believes *S. radialis* to be quite distinguishable and distinct (except from *S. Darwiniana*) from *S. crenistria;* and M. De Verneuil expresses a similar opinion.

Orthis.—Of this genus *O. resupinata*, *O Michelini*, and *O. Keyserlingiana* are well made out species; but the *Orthis? antiquata* has not been sufficiently studied; and indeed all my efforts have been unsuccessful to procure the sight of any other than the original specimen figured in the Geology of Yorkshire, now in the British Museum.

Productus.—Of this genus some thirty species have been retained: nor does the attentive study I have made of the species lead me to imagine them more variable or difficult of recognition or identification than are the other Brachiopoda of the Carboniferous period; but have been perhaps less attentively studied by the generality of geologists. In my monograph I have endeavoured to describe and illustrate all their external and internal details; but with reference to some few the material in my possession or at command was insufficient; and I would urge upon those who may be favourably located to search for specimens which would enable palæontologists to clear away those doubts that may still remain unsolved.

Productus giganteus is both the largest and typical species of the genus, but very variable in its shape. Large examples are abundant in certain localities; while young specimens appear to be less commonly found or collected.

P. hemisphæricus is a badly made out species? and I am not yet able to concur in the opinion recently expressed upon the subject by my learned and much esteemed friend, Prof. de Koninck; and to whose labours science is so much indebted. I am, on the contrary, disposed to believe that Sowerby's figures of *P. hemisphæricus*, belong to varieties of *P. giganteus*. This matter will be further discussed in my monograph, for the limits prescribed to this communication will not permit of more lengthened explanations. *P. humerosus* has been established on some singular internal casts; the shell itself not having been hitherto discovered; but I cannot agree with those who would refer these casts to either *P. giganteus* or *P. semireticulatus*. The prominences in the casts or deep conical hollows (in the shell) for the accommodation of the oral arms indicate that the ventral valve was enormously thickened. The position of the adductor or occlusor muscle in the ventral valve is also slightly different from that common to *P. giganteus*, and which would of itself, in this instance, denote a specific difference. The material, however; is so very imperfect and insufficient that very little can be said upon the subject. *P. proboscideus*, and *P. ermineus*, *P. arcuarius*, are new species to England, and a very interesting discovery entirely due to the indefatigable exertions of my zealous and kind friend, Mr. Burrow, who has in the most liberal and generous manner presented me with his best, and by me figured specimens. The discovery of *P. proboscideus*, (known in one Belgian locality only,) and of so many other species at Settle, in Yorkshire, render that locality especially interesting, as it exactly represents with us the equivalent of the celebrated locality of Visé, in Belgium.

P. sub-lævis is also a new species to Britain; but I am not yet satisfied regarding the differences said to exist between it and *P Christiani*; and should urge a search for more examples of both of these large and almost smooth species of Productus. The first has been obtained at Leek, in Staffordshire, as well as at Llangollen. The second is stated by Prof. de Koninck to be from Wales, but of which the locality is still unknown.

P. Wrightii is a small species with fringe, found by Mr. J. Wright, at Midleton, near Cork, in Ireland, it differs from *P. tessellatus* in several respects, and both appear good but rare British shells. *P. Youngianus* has appeared to me new; and in this opinion I am supported by Prof. de Koninck, *P. carbonarius* (if a good species) is decidedly very rare, for I have never seen more than two British examples which would agree with Prof. de Koninck's description and illustrations of the species. The distinction between *P. costatus* and *P. muricatus* are also difficult to determine, and I am now disposed to believe that if the last is not a distinct species, it may be a good variety of *P. costatus*.

Productus sinuatus, under the designation of *Leptæna sinuata*, appears to have been noticed for the first time in England by Prof. M'Coy, and. notwithstanding its well defined area, should be located under *Productus*, of which it possesses all the characters, with the exception of its well-defined ventral area, a character rare but not impossible in the genus Productus; and I am glad to find that Prof. de Koninck entirely coincides with the opinions I have expressed upon the subject relating to his remarkable species. *P. sinuatus* has also been recently discovered at Bowertrapping, in Scotland; and which I was happy, to recognise among some duplicates kindly presented to me by Mr. Young. *Prod. Griffithianus* de Koninck has been recorded by Mr. Morris and others as a British species; but no examples referable to that shell have come under my observation. We need not prolong our observations with reference to the other well-known species of this important genus, but pass at once to *Chonetes*, for its species appear still involved under considerable confusion, and will require much further investigation under favourable circumstances before they can be properly or satisfactorily arranged. The difficulty is principally caused by a number of badly defined so-termed species, fabricated in Ireland and America on insufficient material.

The only British species which I have been able to recognise with any degree of certainty are *C. comoides*, *C. papilionacea*, *C. Buchiana*, *C. Hardrensis*, and perhaps *C. Dalmaniana*; but I am still uncertain with reference to this last, (although we possess examples identical with those of Belgium,) on account of the great resemblance certain specimens bear to others of *C. papilionacea*. *C. Buchiana* appears to be a well marked species, on account of its fewer or stronger ribs; but these also vary to a considerable extent. It is quite evident that the shell figured as *Lept. crassistria*, by Prof. M'Coy, in the "British Pal. Fossils" is a synonym of *C. Buchiana;* but I am still under some uncertainty whether the typical form of *C. crassistria*, published in the "Synopsis," be really the same. Anyhow, on account of its fewer and simpler ribs, it will be preferable to provisionally locate both it and *C. tuberculata* under *C. Buchiana* as uncertain varieties. The next difficulty is in the determination of what are the synonyms of the good species for which we have retained the designation of *C. Hardrensis*, and of which *C. sub-minima* and *C. gibberula* in M'Coy are evidently synonyms; but I would not venture to speak with so much confidence with reference to *C. volva*, *C. sulcata*, *C. perlata*, and *C. serrata*, M'Coy, all established on imperfect Irish specimens; but it is at the same time highly probable that if not all, the greater number are simple variations in shape of a single species. All we know of *C. sulcata* consists of a single ventral valve. *C. (Lept.) serrata* is fabricated from not even half of a similar valve! *C. volva* bears much resemblance to *C. Hardrensis;* while *C. perlata* is perhaps also a small variety of the same? *C. polita*, M'Coy, although described as smooth? looks very like many examples of *C. Hardrensis* or *C. volva?* in which the ribs are somewhat obliterated. It would therefore be impossible with the scanty material at my command; and in the present state of our information to determine which of these Irish forms are species or synonyms; and it would therefore be very desirable that Irish geologists or collectors should carefully assemble numerous specimens of *Chonetes* from the localities where the so-termed species were mentioned to occur. The *C. Laguessina*, stated to occur at Derwick in England, and Rahoran in Ireland, is probably also nothing more than a variation of *Hardrensis?* Having done all that was within my power to clear up these difficulties, without that success I had anticipated, I must leave the matter as an open question, notwithstanding the advantages I had of being able to examine the original specimens or fragments upon which the so-termed Irish species? have been founded.

Crania.—Three species have been retained; but of these *C. quadrata* is the only satisfactorily determined species. Of *Crania? trigonalis* I have never seen more than the original type, and it is still uncertain whether it is a Brachiopod, notwithstanding that we are acquainted with several similarly striated or costated species in the rocks of other periods. Of *Crania?* (Patella) *Ryckholtiana* de Koninck = *C. vesicularis*, M'Coy, I am acquainted with but a single Irish specimen; but the shell would appear to be less rare in certain Derbyshire localities. It would be very desirable however to procure more specimens of both *C. trigonalis*, and *C. Ryckholtiana*, and especially those showing the interior.

Discina.—Two species only have been retained, viz., *D. nitida* and *D. Davreuxiana* de Kon.; but as of this last but a single example has been found by Mr. J. Wright, in the limestone of Little Island, in Ireland, it is therefore here doubtfully recorded. I may also mention that I am strongly impressed with the idea that the Permian *D. Koninckii* cannot be specifically separated from the Carboniferous *D. nitida.*

Lingula.—The many so-termed species are reduced to four, viz., *Lingula squamiformis*, (which has sometimes attained upwards of one inch and a half in length). *L. mytiloides*, a more elongated species, *L. Credneri*, which may possibly be a variety of *L. mytiloides*, and *L. Scotica* which is separable from all the others by its tapering beaks and peculiar external sculpture.

Having thus briefly exposed the present state of my researches in connection with British Carboniferous Brachiopoda, as well as mentioned some of the difficulties which still beset my mind with reference to the positive value of certain so-termed species, and exposed my ignorance as well as the absolute necessity for much further research, let us cast a rapid glance on the Brachiopodous life during the deposition of contemporaneous (?) Carboniferous rocks in other parts of the world, in order to ascertain whether our British fauna in this respect was not to a certain extent universally represented. In Europe we find that where carboniferous strata prevail a vast majority of the same species exist; and as those of Belgium, France, Russia, etc., are already so well known, from the researches of several distinguished palæontologists, we will at once proceed to India, where out of twenty-five or twenty-six species of Carboniferous Brachiopoda hitherto determined, some fourteen or fifteen were found (on an examination I have recently made) to be specificaly identical with British forms of *Spirifera striata*, *S. lineata*, *S. octoplicata*, (cristata,) *Athyris Royssii*, *A. subtilita*, *Retzia radialis*, *Rhynchonella pleurodon*, *Streptorhynchus crenistria*, *Orthis resupinata*, *Productus striatus*, *P. costatus*, *P. semi-reticulatus* and *P. longispinus*, and a further research in these distant regions will no doubt bring to light a larger number of common species.

The Australian and Tasmanian carboniferous rocks have also afforded their quota of common species, for although the forms from those continents have not been sufficiently examined, still from a passing glance I have given to collections sent home from Bundaba, and Port Stephen in Australia, as well as from Van Diemen's land, I have already been able to recognize *T. hastata*, *Sp. striata*, *Sp. glabra*, *S. lineata*, *Rh. pleurodon*, *Strept. crenistria*, *Orthis Michelini*, *Prod. cora*, etc. If again and by a rapid stride we should find ourselves cast on some of the Spitzbergian frozen coasts, we may there pick up several of our common species, such as *Sp. octoplicata*, *Strept. crenistria*, *Pro. semireticulatus*, *P. costatus*, etc., along with other forms not known in Britain, and lastly, not to extend the limits of this paper beyond reasonable bounds, should we visit the prodigiously extended carboniferous regions of America, we shall there also find a vast percentage of species identical with our own, but which in many instances are still hiding their true characters under the disguise of borrowed names. Possessing as I do a very extensive series of American Carboniferous species, and for which I am indebted to the kindness of Mr. Worthen, as well as to that of some other American geologists, and having compared these with our British species and specimens, I may mention from among others not yet sufficiently studied, the following few as being identical with our own *S. sacculus*, *Athyris ambigua*, *A. subtilita*, *A. plano-sulcata*, *A. lamellosa*, *A. Royssii*, *Retzia radialis*, *Spirifera striata*, *S. bisulcata*, *S. lineata*, *S. Urii*, *S. octoplicata*, *Rh. pleurodon*, *Orthis Michilini*, *Strept. crenistria*, *Prod. cora*, *P. punctatus*, *P. longispinus*, *P. semireticulatus*, *P. scabriculus*, *P. costatus*, *Crania quadrata*, *Discina nitida*, *Lingula mytiloides*, etc.

This rapid but convincing proof of the existence and distribution of many characteristic British species all over the world where contemporaneous carboniferous rocks have been deposited, should inculcate upon us the absolute necessity of carefully examining and re-examining our species, so as to avoid the unfortunate results that may ensue from arbitrarily narrowing their limits of variation—thus violating the law of nature, as well as retarding the advance of science.*

Much indeed may be expected from the rising generation of young naturalists, who, unprejudiced and unfettered, may work out for themselves a new path; and by seeking to determine with more attention than has hitherto been done what are the resemblances that exist between so-termed species, may be able to trace and connect those modifications that have been produced by time and circumstances

* Darwin considers the term species as one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other; and it does not effectually differ from the term variety, which is given to its less distinct and more fluctuating forms: that the term variety, again, in comparison with mere differential differences is also applied arbitrarily, and for convenience sake; that no one can draw any clear distinction between individual differences and slight varieties, or between individual differences or more plainly marked varieties, or sub-species or species.

on the descendants of the parent type, although it would not be possible for me fully to subscribe to Darwin's theory—which I do not perfectly realise, without much further examination and reflection —still there is so much truth in many of his views and statements regarding "The struggle for existence" and "principle of natural selection," that the subject has full claim to a calm and dispassionate examination, and may lead us by degrees to the better understanding of many problems relating to species and their origin than we at present possess.

A CHRISTMAS LECTURE ON "COAL"

By J. W. Salter, F.G.S.

(Continued from page 13.)

In our last lecture stress was laid on the fact that coal-beds, unlike mineral veins, are stratified—not injected, or filling cracks in the earth as metals do. And when we use the term stratified, we mean that the materials we are considering—coal, ironstone, sandstone, clay, shale—were all deposited sheet over sheet, layer over layer, principally by the agency of water.

In scarcely any other way, except by water, can we conceive of materials being spread abroad over vast surfaces, in that even and regular manner which we call "stratified." As a rule, the matters ejected from the mouths of fiery volcanos are only rudely heaped up, and unless they fall into the sea, do not undergo this smoothing, spreading-out process. The sand of the sea-shore however, and the pebbles on its margin, and the mud of its great depths, are truly "stratified;" and if a fertile plain, or a marshy district were submerged in the waters, the materials on that surface would be soon covered over by the ooze and sand and shingle, and would then be said to be "interstratified" with them. In this way coal-beds occur among beds of sandstone and other rocks.

It is seldom that any coal-field contains more than twenty-five or thirty workable seams: and perhaps these altogether do not amount to above eighty or one hundred feet at the utmost, while in South Wales the coal *strata* are twelve thousand feet thick. The mass, you see, is rock.

The miners have names for all the other beds, or "measures" as they term them. Some of them are amusing, In Staffordshire, for instance, the beds of sandstone (once loose sand) receive the names of White, grey, green, and blue rock; Rough rock; and "Peldon." This last is a very common term.

The clays or shales are more oddly named — Clunch; Ground; Partings; Binds; Clod; Shale; Pouncil batt; Table batt; Pricking and Blacktry.

Ironstone beds rejoice in the appellations—Pennystone; Brownstone; Whitery; Lambstone; Blue flats; Cakes; Grains; Gubbins; Ballstone; Bindstone; Silver thread; Diamonds; Getting rock; and "Poor Robins."

The bad coals are — Bass; Smutt; Black bazil, &c. And every coal bed has its name too. There are the—Top four-foot coal; Yard coal; Brook coal: Robin's; Flying reed; Deep coal; Mealy grey coal; White coal! Stone coal; Shallow coal; Old-man's coal; "Heathen" coal; Stinking coal; Bazils; Slipper coal; Sawyer coal; and Bottom coal.

I'm sure that is enough. Moreover, every district has its own vocabulary. Only fancy what the Welsh must be!

But whatever be the kind of bed *over* the coal there is one invariable rule *below* it. A bed of clay, called "fire clay"—a fine soft substance useful for furnace-pots and furnace-bricks — occurs beneath every seam. Sir William Logan, now at the head of the Geological Survey in Canada, first found this out in Wales. It is the clue to the history of coal; and we shall have to refer to it again.

Please to bear in mind that these layers or beds of coal are remarkably regular. It is of the greatest consequence in mining that they are so. If you find, for instance, that the Old Man's Coal is always next to the "Heathen" Coal, and the "white coal" comes next (I don't know that they do), you are safe for the whole coal-field. You have only to measure the distance between the Old Man and the Heathen, and so on, and you know whereabouts to expect them in any other part of the field.

We have reason to believe too that every bed of coal and ironstone has some peculiarity in its fossil contents; and if this should turn out to be true, we shall have a still better means of ascertaining in what part of a coal basin our pits may be sunk—a very important point—for if our mines should happen to lie upon the lowest beds of the whole series, (say at *h*, in the woodcut, p. 9,) it would be a rather unprofitable investment to buy ground there. But if on the contrary, we are likely to be on the "Top coal," why then, work away merrily; we may say, altering Mrs. Hemans' sense, but not her words,—

> "Yet more — the depths have more; — what wealth untold
> Far down, and shining in their stillness lies,"

I will not add another line — for geology does not admit of parodies, and good sense refuses them.

Well, now, we've found our coal. The next thing is to get it. England requires for home consumption and for export nearly seventy million tons per annum; and if you put all her coal-fields together they do but measure nine or ten thousand square miles. Yet by good? management we contrive to get that enormous quantity annually from them. On an average coal fetches nine shillings a ton. So that here is thirty million pounds sterling, and more. Besides we raise four million tons of iron. Each costs about a penny a mile per ton carriage by the railway. And where carts are used, a shilling a mile per ton must be paid for them.* Coal and Iron together would pay two-thirds of our taxes for the year!

America is richer in coal than we are; she has twelve times as many square miles of coal-beds. But her forests are yet so extensive, that she does not—including British America—find it necessary to raise above seven millions of tons a year. This is scarcely so much as France gets from her scanty coal seams. All honour to her genius and industry (would they were always employed in arts of peace); she gets seven and a half millions from about one thousand eight hundred square miles of coal. But what shall we say of little Belgium, which raises eight millions out of her five hundred square miles! Belgium has plenty of iron too, and she *makes* muskets, but does not wish to *use* them.

Russia will scarcely tell us much about her coal-mines. She gets less than a million tons per annum! Austria is almost equally poor; and the whole of Germany does not raise much above five millions.

England has very nearly three thousand collieries in profitable work, and four government inspectors to see that they are safely handled.

As the beds in a coal basin, though regular, are often much broken, it is usual to bore the ground before commencing the operations for extracting it. The boring apparatus is very simple. It consists of a gigantic gimlet, which from its weight also acts as a chopper or a chisel. It is made of iron, tipped with steel; and of joints which screw together as they are successively pushed down — the point being either a cork-screw or scoop for soft strata, clay, &c., or a chisel for harder rock. The principal instrument in use is called a "wimble." It consists of a steel cylinder, or rather a plate of steel rolled round into a cylindrical shape, but so that the edges overlap a little; and it is found that this curled-up plate, with a square notch cut out of the sharp-edged end, is about the best form for the double work of chiselling the stratum and bringing up the fragments. Then there is a scoop for mud called a sludger; and a great many varieties which may be screwed on to the end of the rod. But the main end and object of all, is to cut the beds through, one after the other, and bring up such fragments to the surface as shall show the nature of the ground through which the rod passes. The instrument is worked by four men when the depth is not very great; but horse or even steam-power must be used in deep borings; and the work is very expensive, since the rod must be continually drawn up and the fragments removed. For eight hundred feet down they can tell very accurately what beds they are passing through.

* My friend, Mr. Robert Hunt, supplied me with these facts about our coal consumption.

All this is only preliminary: there must be a door to your house if you are to get into it, and the shaft is the door to a coal mine. This is the first thing to be completed. It must go the whole depth of the mine, in order that they may get rid of the water that soaks through the strata. This is man's great enemy when he is mining—at least the first one—for bad air is at least as great an enemy afterwards.

The shaft then is sunk to the "dip" end of the main, or lowest level of the floor, in order that all the water which may percolate into the workings may eventually flow down into the "sump" or cistern that lies at the bottom of this "engine shaft."

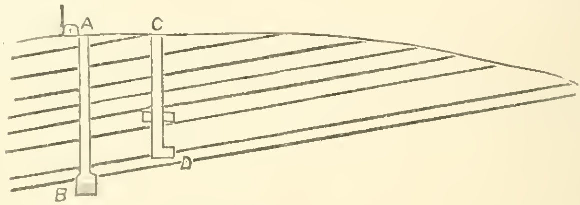


Fig. 3.—Diagram of Shafts,
a b, engine shaft,—*b*, the "sump," or cistern; *c*, upcast shaft,—*d*, its furnace.

It is no light work to sink a shaft—eleven or twelve feet wide—to a depth of perhaps one thousand feet. The materials are sometimes very soft, as shale; but this has the disadvantage that you must line it with brick or wood throughout. Sometimes the rock is hard enough to stand alone; then the matrix is a tough rock and very difficult to cut. Oftentimes the leaky state of the bed makes it necessary to line it with wooden "tubbing" throughout; and this is an old custom. More recently it has been found advantageous to use iron cylinders the whole way! A shaft a thousand feet deep will ordinarily cost about three thousand pounds; and if a two hundred and fifty horse-power engine be required, there is another five thousand pounds to begin with; and while on the subject of expense, it may be well to say at once that fifty thousand to two hundred thousand pounds are no uncommon sums required to set a colliery fairly going, before a bucket of coal is drawn. But then if it yields—and it ought to yield—twelve per cent., it is no bad speculation after all.

They generally find too they must sink two shafts; and the pumping engine will not do for drawing also. The two shafts are required for ventilation; and they serve also to prevent the mischief of letting everything down and drawing everything up the engine pit. We will leave the ventilation alone just now; and only say with reference to the engine that the quantity of water required to be removed is often enormous.

The way in which water finds its way into a coal pit is the same as that in which it finds its way into Artesian wells. The water comes from the surface, *a*, *a*, runs down the porous strata, till it comes to the bottom of the basin, and there finds its own level. It will not run through the clay *(b)*, and hence you have only to drain what lies above it in the strata, *a*. Nay more, if one part of the basin be cut

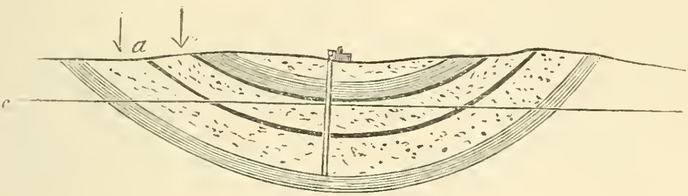


Fig. 4.—Section of Coal Basin.
a, porous beds; *b*, clay; *c*, water level.

off from the rest by faults, as in our diagram, p. 9, only what lies on its own side of the fault will have to be drained by any shaft. So that a fault is a positive advantage, paradoxical as it may sound.

Though they cut up, and often tumble the beds much, yet being filled with clay, they effectually shut off the water of one compartment from the other: and render it possible to work in the dry, when otherwise you would have to work in the wet. Like many other apparent disadvantages, they do good after all.

We may guess what a terrible plague the water is to the miner, when we know that in sinking some shafts, the engine has had to draw off three thousand gallons a minute, with a pump eighteen inches diameter. It is still worse in the Cornish tin mines.

It is a curious fact that in deep mines the water is generally salt—often salter than the sea. It often, too, contains green vitriol (sulphate of iron) iodine, bromine, and other constituents of sea-water, which no doubt it once was. We shall see that by and bye.

And now we've got our shaft down to the lowest point—our pumps at work—nearly all our money spent; and we have to find out how to work the pit to the best advantage: for some pits will send up three hundred or four hundred tons a day; and an acre of coal with sixteen thousand tons in it may be cleared off, by a good method of working, in six weeks!

The winding engine or "whimsey" is not nearly so powerful as the pumping engine—seldom one hundred horse power—and round the drum over the pit's mouth are coiled the flat chains (of three or four links,) or strong ropes, which last they find best for drawing coal.

The baskets or "skips" are of various shapes in different mines. A common form, which strikes a stranger with some surprise, is a low flat box on wheels, on which the coal is piled; and when the pile is high enough, a broad iron hoop is thrown over it; more coal is added; other hoops thrown over that—till the pile is as high as can be raised with safety. The hoops effectually prevent the coal from falling off; but it has an odd appearance, like a black crinoline petticoat.

Suppose then the miner at the bottom of his shaft, it is not all straight forward digging then. There is a structure in coal, and he must take advantage of it. It is full of joints which cut it up into squarish pieces; one set being backs or cutters, and the other joints; and the art is to drive the pickaxe and lever along these two sets so as to work the coal in the easiest directions.

This structure can be seen even in the little specimens in our own coal scuttles, and is due to the pressure the coal has received since it was hardened. There is nothing crystalline about it, as some have fancied. It is a sort of cleavage.

As most coal lies on a slope, the first gallery is driven horizontally along it at the lowest level, *a*, *a*. This horizontal gallery, which must

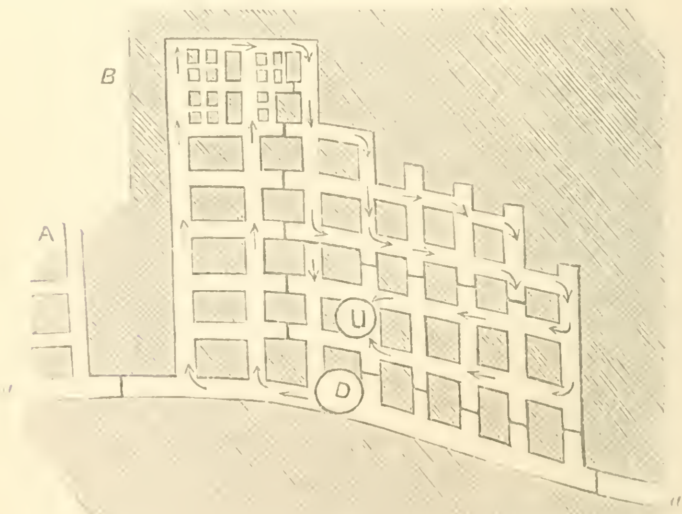


Fig. 5.—Plan of Mine-working.

follow the curves of the strata, if there be any, is called the "dip-head level;" from this they drive galleries *upwards*, (the coal is brought much easier down than up) from *a*, *a*, to A and B in our plan, and cut cross ones at right angles—keeping all at quite regular distances; and so proceeding forwards and sideways, in squares, to the extent of their working, or of such portions as they choose to work out first. The galleries made by the hewers are called "stalls"; the pillars of coal left between are called "posts"; and the usual mode of working is to go over the whole space in this way, leaving posts large enough to support the roof, and gradually driving the galleries or stalls forward, up the slope of the mine.

The coals are brought down the galleries, which have each a tramway laid in it, in small wheeled cars, which either carry the skips or are themselves detached from the train, hauled up, returned empty, and again wheeled up by the "putters," or boys employed for this purpose. Ponies generally draw the loaded cars in lines along the diphead level to the mouth of the drawing shaft; and these ponies, sleek and well-fed, live in the warm mine and like it. They learn to hold their heads low, for there is never too much space in a coal gallery; and if we would imitate them, we should escape many bumps through life.

When all the galleries are cut, then they begin to thin the "posts"—and this is a work of some little danger. Not only is the roof inclined to come down on the miners' heads, but the floor often bulges up beneath their feet. Such a disturbance of the ground, arising from the great pressure above, which forces down the pillars into the clay beneath, is called a "creep." It has an odd effect on the buildings over the colliery. They begin to fall sideways out of the perpendicular; square windows take a lozenge shape; doors, &c. will not open, being jammed at one corner. Ceilings fall, bit by bit, upon the inmates; and altogether a "creep" produces unpleasant feelings for all concerned. But it cannot be helped—the black stores below are worth more than the buildings above; and, therefore, they must go the way of all buildings.

The process of thinning may begin at one corner, *a*, (the furthest from the shaft,) before all the galleries are finished; and when a good many of the "posts" are thinned as much as they will bear, they extract even these, substituting wooden posts for coal ones. The space then looks like a forest of dead props, among which you may easily lose your way; and, as these decay, down comes the whole mass, slowly but surely, till the roof and floor meet in a broken irregular mass. The hollow space with its ruin of shale and sandstone—of sound and decaying props, is then shut off from the other compartments of the mine. No ventilation is further given to that quarter, called a "goaf," and foul gas and tar-water, and every abomination, may collect there till time shall end. It is a sort of Tophet.

There is another way of working, much used in thin seams and small collieries, and universally preferred in Scotland. It is "long wall" working. In this method the galleries are driven (as before from a dip head level) parallel to one another the full extent of the mine, but not near together, and the coal between the ways is then worked out bodily;—small entries being made through the wall, and all the intermediate coal "got" out, enough only is left along the sides of the ways to ensue the safety of the latter.

Our diagram shows a piece of this sort of work. (*See p.* 66).

The rubbish, (roof, floor, &c.,) which must be got out in the main ways with the fuel in thin seams of coal or ironstone, (for ironstone is got in almost every coal pit,) need not be taken away; but is filled into the empty spaces, *b*, as the coal is extracted. And a sort of bed is thus made to receive the descending roof. It is stifling work in these thin seams when the poor hewers have to lie on their sides and ply their picks against the black wall in face of them, with a yellow

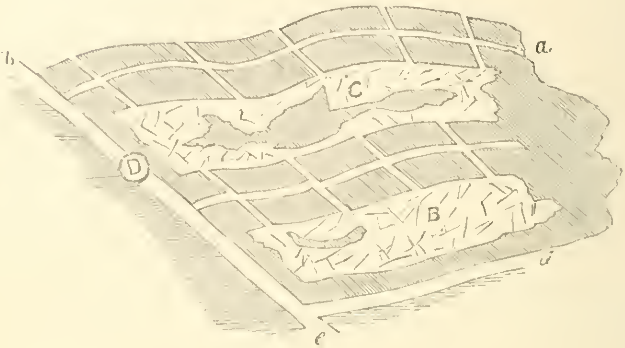


Fig. 6.—Plan of worked-out Mine.
a, the galleries with their walls of solid coal; *B, C*, the "goafs," or worked-out spaces filled with shale and rubbish; *D*, shaft; *b e*, dip-head level.

candle flaring in the one hand, (or a Davy,) the elbow resting in a hole cut to receive it, and the whole man sweating in a hot atmosphere for hours together. It is a heavy price to pay for comfort above ground. But they do not murmur; and a good hewer will clear eighteen shillings a week, after paying for his candles, tools, &c.; while the overmen receive twenty-five to thirty shillings.

The thick coal of Staffordshire was formerly mined on the "pillar and stall" system; and Mr. Warington Smyth has given a graphic picture of a "side of work in the 'thick seam,' when a large fall of coal is brought down from the dusky heights of that lofty chamber. The thunder of the falling masses, which seem to shake the solid earth, contrasts fearfully with the dead silence that ensues. The hardy colliers scarce break it by a whisper, while in suspense they listen for the slightest crack which might portend a further fall." But the enormous height of this coal-chamber, often thirty feet, was of itself a source of danger; and the pillars required, and which must be all waste, so large, that it is now found profitable to work it in "long-wall" method, a half or more of the seam at a time, beginning at the top. By this means they get all or nearly all the coal—about thirty thousand tons to an acre. They used to get but sixteen thousand. There are four hundred and twenty collieries in this district alone. About one third of the coal they raise is expended in their furnaces; (for near a million tons of ironstone are raised in this field annually, besides the coal formerly mentioned, page 10). About half as much is sent from other places; and a year or two back this quantity produced six hundred thousand tons of pig-iron from sixty-four furnaces. There are one hundred and two mills and forges in the Staffordshire district. For this information, also, I am indebted to Mr. Robert Hunt, of the Mining Record Office.

We are not talking, however, of Staffordshire, but of coal mining in general, and now a word on the ventilation—the most important of all things for a mine after the water has been expelled.

Without a furnace to create an upward draught in the one shaft, so that the air may rush down the other and travel through the mine, the work would be well nigh impossible. The way this precious air is made to circulate throughout, instead of merely going from one pit to another, is partly explained by our diagram, fig. 5, p. 64. The arrows point the way the air goes up one side of the workings, round the further end, along the working faces of all the galleries, and then back again nearly to the same point to the upcast shaft, *U*. There the contaminated air, after passing the mouth of the burning fiery furnace, gains the upper world, and makes room for a better and purer element. The air is restricted to this course by the air-doors, which are marked as black lines in our plan, across the galleries. These are strongly framed doors, of iron chiefly, and are kept by boys, "trappers," as they are called, whose sole and solitary work it is to open and shut these trap doors whenever a train of waggons passes. A few words of converse with the "putter" lads, who bring the loaded skips down the "ways"—or it may be, quite as likely, a scuffle with them—are the only relief these poor boys have (they are mostly very young) during the dark and solitary hours. They cannot afford a "low" or candle for the "trapper" boys!

In most of the important mines, a separate "windway" or "airhead" is driven by the side of the galleries (or an air-tight wooden tube is carried along), exclusively devoted to air from the downcast shaft; and then, after supplying the miners in the stalls, finds its way back along the galleries, escaping every time an airdoor is opened. The same method is adopted in longwall work. But occasionally, as I learn from Mr. Smyth, they work two galleries side by side; and use one of these for the incoming air, and the other for the return draught. Whichever mode is adopted, the principle is the same, viz.: to carry the air all round the mine, drawing it forcibly down one shaft and up another, at the other end of the system. Be it remembered the actual heat of the earth is much greater below the surface than above; that choke-damp (an elegant term for carbonic acid) and other poisons too sometimes, are present in the mine; and ventilation, whether by fans or furnaces, will be seen to be vital to the work.

Any neglect in this important matter exposes the miners not only to the displeasure of the overseers, and the ill report of the government inspector, but to the positive danger of explosion from the foul gas, which is ever accumulating in the mine. The fearful fire-damp, which has played so terrible a part of late, is generated rapidly in the coal pit. It is carburetted hydrogen, the same gas which burns harmlessly in our streets. It rushes out from many a fissure and dark chamber upon the miner, who, in spite of all the precautions taken for his safety, often ventures on his work with a naked candle, instead of the useful instrument which Davy and Stephenson had given him.

I need not speak of this "wonderful lamp," which lights to treasures as valuable and far more durable than those Aladdin found. Who would have thought, when Davy was pondering on the fact, that flame did not pass readily through narrow tubes—and trying shorter and shorter lengths of these in philosophic sport—that he was really making a discovery which has saved the lives of thousands.

The government inspection, now regularily carried on, will do much to encourage those that do, and shame those managers that do not conform to the regulations laid down for their benefit. But more, a great deal more is be looked for from the education of the miners and their children. They have friends for the body, and for the mind too; and a life spent underground cannot kill out the intelligence and virtue of a man who is determined to hold it fast.

And now we have done with coal for the present, let us try and find out how it was formed.

It is perfectly understood that it is made up of plants. We need not enter again into that proof: coal is full of them. You cannot stand five minutes by the side of a shaft, and look at the heaps of dark blue shale brought out of it, without finding them full of fern-leaves, and grass-like plants, and bits of diapered or fluted cylinders highly ornamented; with occasional fir-cones, or what look like them, and a heap of other fragments. The coal itself bears witness to the quantity of plants in and about it. It is generally too solid—too crystalline so to speak—to show its structure well. But here and there the charcoal fragments in it are covered with vegetable tissue, and the microscope reveals still further traces. Of these I will say a little more in our next number, for my space and time too are somewhat limited at present; and with the fact that plants in myriads are found *in* the coal, *above* the coal, and *under* the coal, I must request my young readers to be contented till next month.

(To be Continued.)

ON SOME NEW FACTS IN RELATION TO THE SECTION OF THE CLIFF AT MUNDESLEY, NORFOLK.*

By Joseph Prestwich, F.R.S., F.G.S.

In the fine coast section extending from Happisburg to Weybourne, the Boulder clay is laid open to an extent nowhere else equalled in England. The relation of this Boulder clay, on the one side, to the Forest bed and Crag underneath, and, on the other, to the series of

* Read before the Meeting of the British Association at Oxford, in June, 1860, and published by permission of the Author.

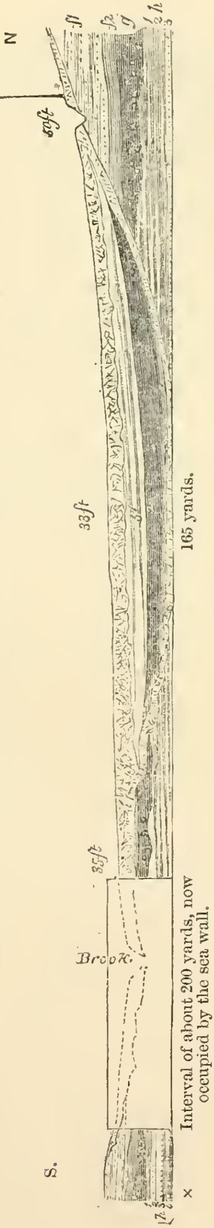
sands and gravel above it, is there exhibited in full detail and great variety. It is our type section of the Glacial period. In the interesting account of this coast given by Sir Charles Lyell,* in 1840, one place is noticed, where, owing to the wearing away of the cliff considerable changes have since taken place, and a section of importance has been more clearly exposed than it was at the period referred to. I allude to the section at Mundesley, where the Freshwater deposit was thought to be intercalated in the Boulder clay—an anomalous position and one difficult of explanation.

In my paper read before the Royal Society, in May, 1859, speaking of the flint implement-bearing strata at Hoxne, I mentioned Mundesley, amongst other places which are probably synchronous with it. I am therefore desirous to show, briefly, the nature of the resemblance, and to prove that this Freshwater deposit really *overlies the Boulder clay and is not intercalated in it.* It is not as a matter of controversy that I now bring the subject forward, but merely as one of fact, for I believe that all geologists who have lately visited the spot, including Sir Charles Lyell himself, now view the section in the same light. (See section, fig. 1.)

I was at once satisfied that such was the order of superposition when first I visited

* Phil. Mag. for May, 1840, p. 353.

Fig. 1.—Section of the Cliff at Mundesley, Norfolk.



a, Sub-angular flint gravel.
b, Freshwater deposit. 1. Upper sandy beds. 2. Black, 3. Brown peaty beds, with bones, shells, insect-, and fish-remains. 4. Sub-angular flint gravel.

f, 1. Light yellow sandy loams. 2. Laminated grey sandy clay.
g, Lower division of Boulder Clay.
h, 1. Laminated grey clays and yellow sands in alternate layers. 2. Coarse sand and fine gravel, with clay seams. 3. Yellow sands; seams of grey clay, full of freshwater shells at ×. *Mytilus*, *Littorina*. Elephant bed at base of this series, immediately under which is the Forest bed.

[The upper numbers give the heights.]

this coast in 1848, and several visits since paid to it, in company with Mr. Morris, Mr. Godwin-Austen, and other geologists, confirmed myself and my companions in the same view—a view, I find, which agrees with that taken by the Rev. Mr. Gunn, who has made this part of the coast his especial study for some years past. So variable, however, is the condition of the cliff, that on each occasion some new point of interest has been displayed.

Commencing with the lowest beds of the series, the Chalk and overlying Crag are not exposed. The dark sandy clay (*g*), known as the Forest bed, from the abundance, amongst other remains, of stems and trunks of trees found in and on it, here forms the base of the cliff; but it is only exposed at a few spots, and when the talus, too frequent at the foot of the cliff, is washed away. Immediately upon it is a thin bed of sand, gravel, and clay, in variable proportions, containing a number of mammalian remains, and especially characterised by the *Elephas antiquus*.

Above this is a series of thin beds of sand (*h*), with subordinate gravel and clay seams, together from twelve to twenty feet thick. No fossils had hitherto been found here in this part of the section, but in a visit there in 1858, the Rev. Mr. Gunn showed me, on the south of Mundesley, a thin seam of pebbly clay (×) in the lower part of this series, and only one or two feet above the Forest bed, full of Freshwater shells, chiefly *Unio*, *Cyclas*, *Pisidium*, etc., all, I believe, of recent species, and like those in the overlying Freshwater deposit (*b*). * On examining the same zone, on the north of Mundesley, I could not find the same clay bed, but I found in a higher seam of sand *Cylas* and *Succinea;* and further I found above this level, and in the middle of *h*, a thin seam full of some marine shells, but in a very fragile condition. They consisted of the common *Mytilus edulis*, with *Balani* attached to some *Littorina littoralis ? Natica*, and one or two other indeterminable specimens. Above this series (*h*) is the great bed of Boulder clay *(g)*, here not more than seven to fifteen feet thick. North and south of Mundesley, this is succeeded by a series of laminated clays, upper Boulder clay, loams and sands, *(f)*, of great thickness—with a bed of gravel capping the whole. But at Mundesley these upper beds have been removed and an old valley, the bottom of which is occupied by a Freshwater deposit, cut through them. The section, which is well exposed in the cliff, shows the former old valley to have been deeper than the present one, and scooped out through all the sands and gravels *(f)*, the Boulder clay *(g)*, and down nearly to the so-called Forest bed. The bottom of this depression is lined first by a bed of gravel, and then filled up to the depth of twenty to twenty-five feet by a peaty clay, abounding in

* It is probable that this bed of Freshwater clay, before the building of the sea-wall might, without a clear exposure of the cliff, have had the appearance of being prolonged from *b*—being on the same level, and much like in mineral character. The bed of gravel (*b* 1), which necessarily cuts off all communication with the beds beneath, clearly isolating and separating the upper Freshwater beds (*b*), from the lower one (*h*).

land and Freshwater shells, all of recent species, together with remains of fishes and insects; and for the list of which I refer to Sir Charles Lyell's paper. Some mammalian remains have also been found, but the only bone I myself obtained was, apparently, that of the ox. Now this deposit is underlaid throughout its width, and thereby distinctly separated from the Boulder clay, by the bed of ochreous flint gravel (b^4), two to four feet thick. It is overlaid by by another bed of gravel and brick earth (a), of five to ten feet, also newer than the sands and gravel (f). The way in which these two gravels merge one into the other, at each end of the section, is very instructive.

In superposition, therefore, above the Boulder clay, this bed resembles the Hoxne deposit, as it does likewise in its Freshwater character and shells, and in its unconformity to the existing line of drainage; for a reference to the section will show that this Mundesley deposit is not exactly coincident with the line of the present valley. I consider it is a deposit in which flint implements like those of Hoxne may probably be found — especially, however, would I suggest a careful search to be made in sandy part (b^1), and the gravel (b^4). The determination of the exact superposition of this bed is further of consequence, inasmuch as some important questions, connected with the fauna of the pre-glacial and post-glacial periods, hinges materially upon it. In this inquiry, therefore, I have, for the present, limited myself merely to the question of position, and to pointing out the presence of the Freshwater shells at h^3, and the band of mussels in h^2, otherwise leaving aside the other important question of organic remains.*

I have annexed a rough but proportionate and measured section of the beds, taken at different favourable periods.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Royal Institution.—Dr. Tyndall's lecture on the 18th ult. was a memorable one in the annals of even that famous institution, of which Faraday is one of the brightest ornamants. The Radiation of Heat is an old and familiar subject; but Professor Tyndall has crowned it with some new and most important facts — "On the Influence of Gases and Vapours upon the Rays of Heat Emanating from a Dark Hot Surface."

Before an audience of five hundred persons, of the highest rank and education in the metropolis, Dr. Tyndall, pale with anxiety for the success of those experiments, almost unrivalled in their delicacy, on which the enunciation of his important facts depended. demonstrated forcibly the new truths that the heat radiated from dark bodies differs in many respects from the heat radiated by

* I am happy to say that the fossils, both of the Forest bed and of the Freshwater beds *(b)*, are now engaging the active attention of a very zealous observer, who will, no doubt, add materially to our present lists.

luminous bodies. The solar rays reaching the earth lose some of their properties on radiating from it—for it is well known all material substances not absorbing heat are radiating it, and by the aid of instruments of the most refined character, Dr. Tyndall has determined that such dark heat-rays pass without loss through absolutely dry air—that they permeate many of the gases; but their progress is arrested by the perfectly colourless and transparent olifiant gas. Amongst vapours the dark coloured bisulphate of carbon opposes no obstruction, but the attenuated vapour of ether stops them completely; while the vapour of water admits of their permeation with difficulty. Carbon-vapour in the air would facilitate the radiative action of the earth's surface, and occasion its rapid cooling, but water-vapour prevents the heat radiations from passing away, and preserves that temperature necessary for the existence of animals and plants. The warm gulf-stream, impinging on our coast, charges the air with moisture, and this envelope spreading over our island compels the heat absorbed from the sun by day to be retained in the earth at night, but if any circumstances produced a drier atmosphere we might suddenly find ourselves reduced to all the severities of an arctic climate.

What are the bearings of these new facts on the ancient geological condition of the Carboniferous age and the Glacial period, are questions at once suggested to our mind, for it appears to us that the presence of a large quantity of carbon-vapour in the atmosphere, as there has been generally supposed to have been in the Coal-era, would of itself have facilitated the radiation of heat from the earth's surface, and have promoted its rapid cooling; but as besides this additional quantity of carbon, there is supposed to have been a vast amount of moisture in the air, we have thus to consider what would be the effect of the commingled condition on the climatical state of the globe during that interesting and important era. The effect of a drier atmosphere in allowing the free radiation of heat is also, evidently, a point which cannot in future be left out of our speculations, on the causes of that extraordinary period of cold—the Glacial period.

Geological Society of London.—*December* 19, 1860.

1. "On the Geological Structure of the South-west Highlands of Scotland." By T. F. Jamieson, Esq.

2. "On the position of the beds of the Old Red Sandstone in the Counties of Forfar and Kincardine, Scotland." By the Rev. Hugh Mitchell. Communicated by the Secretary.

January 9, 1861.—1. "On the Distribution of the Corals in the Lias." By P. B. Brodie, M.A., F.G.S.

2. "On the Sections of the Malvern and Ledbury Tunnels, on the Worcester and Hereford Railway, and the intervening Line of Railroad." By the Rev. W. S. Symonds, A.M., F.G.S., and A. Lambert, Esq.

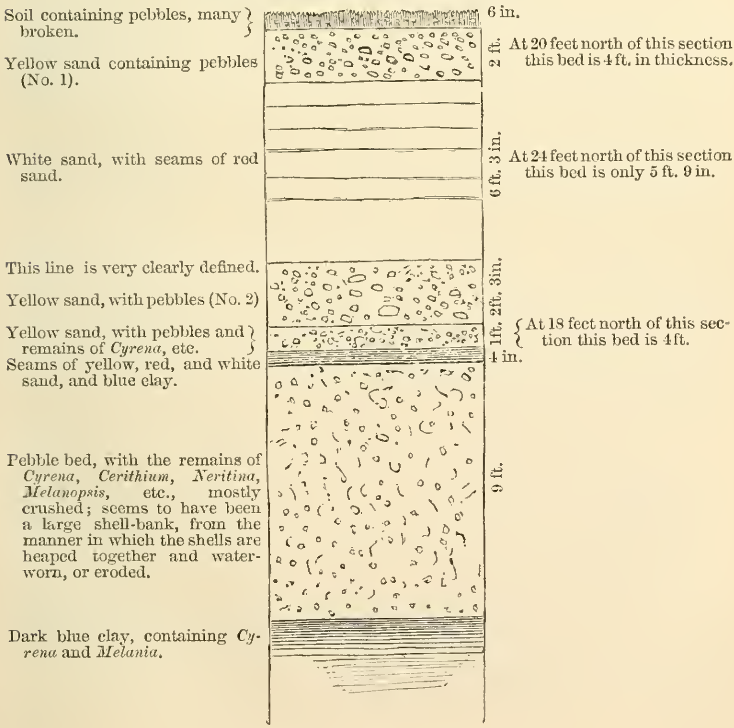
NOTES AND QUERIES.

Pterygotean Ova.—Where through the English range of the "Old Red" tilestones has Pterygotean ova (*Parka decipiens*, Page) been met with besides the Trimpley quarry, near Kidderminster?—George E. Roberts.

Fossil Orangs.—Mr. R. W. Wallace in a most able paper on the Borneo orang, says: "One cannot help reflecting on a former condition of this world which would give a wider range to these strange creatures, which at once resemble and mock the "human form divine"—which so closely approach us in structure, and yet differ so widely from us in many points of their external form. And when we consider that almost all other animals have in previous ages been represented by allied yet distinct forms—with what intense interest and anxious expectation must we look forward to the time when the progress of civilization in those hitherto wild countries may lay open the monuments of a former world, and enable us to ascertain approximately the period when the present species of orangs first made their appearance, and perhaps prove the former existence of a allied species still more gigantic in their dimensions, and more or less human in their form and structure!"

Beds of Flint Pebbles at Charlton.—Mr. Edm. Jones having informed me of the remarkable difference in the character of the two beds of flint pebbles at Charlton, near Woolwich, and presented specimens, I requested him to furnish me with a section showing the position of the beds, which he has kindly done. The flints from the upper or No. 1 pebble-bed are readily broken by the slightest blow of the hammer; while those from the lower, or No 2 bed are intensely hard and tough, and are broken only with the greatest difficulty. It is not easy to perceive the reason of this difference, as both are ordinary chalk-flints.—S. J. M.

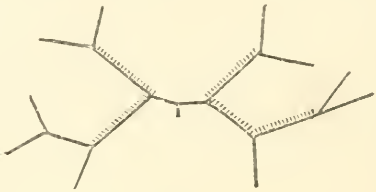
Section at Charlton (Mr. Allen's Pit).



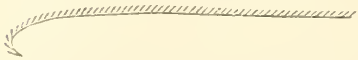
New Fossils from Skiddaw Slates.—Sir,—I think it is worth while to call the attention of your readers to a new and very interesting locality for fossils—in the celebrated Skiddaw slates. Mr. Bryce Wright, of Russell-street, who is well known in the natural history trade, devotes some time annually to collecting them: and he has a store on hand, from the neighbourhood of Keswick, of the *Graptolites sagittarius*, *G. latus*, *G. tenuis*; also a new Crustacean form allied to *Dithyrocaris*, very abundant.

New Crustacean from Skiddaw-slates.

Lastly, he has discovered—and we owe him many thanks for doing so—the branched Graptolites (which Sir W. E. Logan first brought to light in Canada), of this shape.



Prof. J. Hall considers them only to belong to the genus *Graptolites*, which has a simple stem with one row of cells. But this is certainly not the case, for the true simple Graptolites are perfect from end to end. I shall shortly, I hope, describe the new branched dichotomous form under the name of *Dichograpsus*; meanwhile I think I am doing some service by calling the attention of those living near the Skiddaw slates to the unexpected riches of that formation.



Trails of worms (and those abnormal things called fucoids), are abundant enough everywhere in them. But no good list has yet been published; and the formation is almost a virgin one for explorers.

Can no one find the Lingula flags on the flanks of the Saddleback? We are beginning to disbelieve in *metamorphic* rocks being unfossiliferous.—Yours truly, J. W. Salter.

Geological Guide to the Onny Valley.—In commencing a geological trip up the Onny Valley, the most convenient place to start from is the Craven Arms, a station on the Shrewsbury and Hereford Railway; and taking the turnpike-road towards Shrewsbury for about a mile, a stile is reached on the left hand side. whence a foot-path leads across a field near the bridge over the Onny River. Proceed along this path about three hundred yards and cross over the railroad, then turn down to the river and follow up the stream to the top of the meadow—the Wenlock shale may there be observed exposed in the river bed, and if the water is low some fine specimens of *Phacops longicaudatus* may be procured, together with *Calymene tuberculosa*, *Cardiola interrupta*, *Loxonema elegans*, *Orthoceras subundulatum*, *Beyrichia tuberculata*, and *Graptolithus priodon*. The most prolific beds are just below the fence, close to the left hand bank. Keep on up the side of the brook until arriving at a foot-bridge, which cross and immediately go into the field above; nearly at the further end is the celebrated "Onny Section," showing the lower members of the Wenlock shale, (or Purple Beds,) the Llandovery or Pentamerus limestone, and the upper beds of the Caradoc sandstones, lying nearly conformable, and in one continuous section.

From the Wenlock shale has been procured *Cheirurus bimucronatus*, *Encrinurus punctatus*, *E. variolaris*, a new trilobite; *Orthis biloba*, *Beyrichia tuberculata*, *Leptæna lævigata, Strophomena pecten, Atrypa reticularis, Rhynchonella furcata, Petraia bina.* The only fossil that I am aware of having been found in the Pentamerus limestone, in this locality, is *Pentamerus undatus;* it is a very thin band here, and only to be observed by careful search; it lies about the middle of the section. From the Caradoc sandstone at the further end of the section, some very fine and perfect *Trinucleus concentricus* have been observed; several heads of *Ampyx pinnatus,* and one entire specimen; fragments of *Remopleurides radians, Illænus Davisii, Calymene Blumenbachii,* a new *Raphistoma, Orthis elegantula* and a new fossil allied to *Siphonetreta.* At the top of the second meadow above this place again cross the stream, at a spot where a pole hung by a chain is suspended, and on the side of a section of Caradoc sandstone, a new fossil *Sphærospongia hospitalis* may be readily observed, as the marks of hammers show clearly the exact situation in the cliff where they are to be found; and besides this new fossil, many others belonging to this formation are there to be procured. Continue up the stream to Longville Common, where a quantity of loose stones, of a greenish olive and yellowish brown colour have been thrown down from several old quarries above, belonging to the middle Caradoc formation. These stones here are rather barren: still some good specimens of *Modiolopsis orbicularis, Bellerophon bilobatus, B. acutus, Strophomena expansus,* and several species of *Orthis* may be procured. At the further end of the common, cross the river by the stepping-stones, and immediately over the turnpike-road leading to Bishop's Castle, is a large quarry of Bala limestone, the beds of which are all pitched up perpendicular, owing to several large faults in the neighbourhood. The stone is very hard, of a light blue colour, and much used for road-purposes; few fossils have been obtained, being here a rather barren rock; but Mr. Salter, Palæontologist of the Geological Survey, found a short time ago a new Lingula, which may be obtained in abundance; small portions of *Diplograpsus pristis,* some very large *Strophomena grandis,* with other organisms are to be found. The lower members of the Caradoc sandstone lie conformable to it on the lower side of the quarry, and some of the beds are very rich in organic remains; the best beds are about half way up the bank, and may easily be known by the hollows in the side, where the right strata have been worked, the stone is of a light brown colour, and of a tough sandy character. A sharp chissel-shaped hammer is the best for these beds. Some perfect *Trinucleus concentricus* have been observed here, together with a new *Asaphus;* several other Trilobites, which I think are not described; some very beautiful *Fenestellæ, Beyrichia complicata,* and several fossil shells. These beds would probably yield several new organisms, if a careful search were made, as hitherto they have received but very cursory inspection from geologists.

About a mile and a half higher up the road, is a hill called the "Broken Stones," the lower part of which is composed of the Longmynd or Bottom-rocks; and the top of Caradoc sandstone, very poor in fossils. All the rocks here are very much pitched about in consequence of numerous faults.

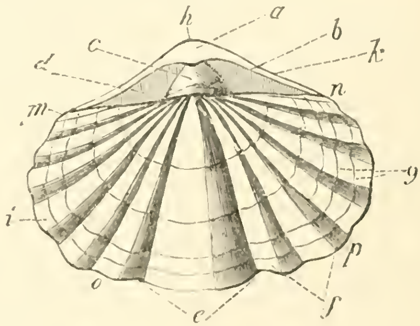
From the Bala limestone to the Wenlock shale, which are about two miles apart, the road, with the exception just mentioned, passes through the lower beds of the Longmynd rocks, from which no fossils have yet been obtained.

After passing the Wenlock shale, in which no sections are to be seen, the road again passes through the Caradoc sandstone, which continues to the Marsh brook; on the sides are several quarries full of the general remains peculiar to this formation. The most prolific section is in the private drive, close to Marsh Brook Station through the coppice to Minton, where a large proportion of Caradoc fossils are to be procured. The following are some of them that have been obtained there:—*Tentaculites anglicus, Phacops conophthalmus, Homalonotus bisulcatus, Trinucleus concentricus,* crinoid plates, species of *Fenestella, Nebulipora lens, Orthis unguis, Orthis elegantula, Orthis vespertilio, Strophomena* *grandis*, a new species of *Trematis*, a species of *Ambonychia*, *Bellerophon sulcatus*, *Modiolopsis orbicularis*, *Lingula ovata*, and a species of *Nucula*.

The reader is referred for further information on this interesting and beautiful locality to Messrs. Salter and Avelin's paper, in the tenth volume of the Quarterly Journal of the Geological Society.—A. Marston, Ludlow.

Terms used in the Description of the Brachiopoda.—Sir,—I should be greatly obliged if some of your correspondents would favour me with a definition of the terms "mesial fold" and "beak ridges," which occur in Mr. Davidson's valuable monograph on the Brachiopoda, published by the Palæontographical Society. These two expressions, which are used frequently, are not explained, as I am aware, in the body of the work.—Yours, A Student.

Our correspondent enquires what is meant by the term "mesial fold" and "beak ridges;" perhaps the accompanying sketches will explain these and other terms better than could be expressed by words.



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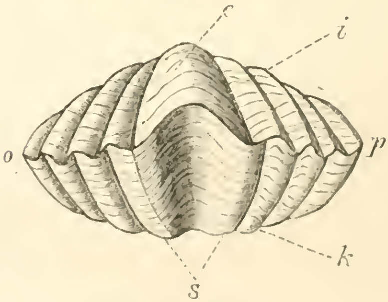

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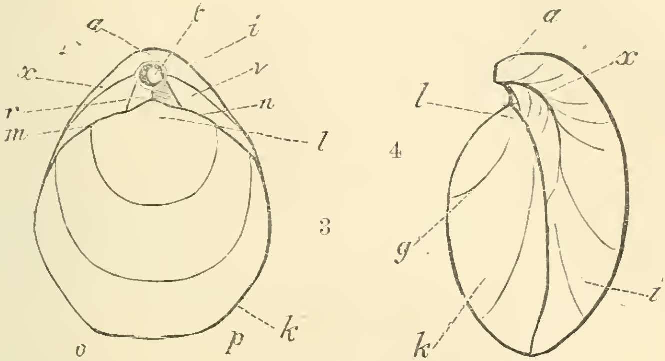
Figs. 1 and 2.—*Spirifer.*

i, smaller, or dorsal valve; *k*, larger, or ventral valve; *a*, beak; *b*, fissure; *c*, pseudo-deltidium; *d*, area; *e*, mesial fold; *f*, ribs; *s*, sinus; *g*, lines of growth; the line *m n* is the hinge line; *m* and *n* are the cardinal angles, which may be angular or rounded; the line *m h* and *h n* is the cardinal edge; the margin between *o* and *p* is the frontal margin; between *m* and *o*, or *n* and *p* the lateral margins.

The "mesial fold" is therefore a longitudinal mesial elevation which often exists in the dorsal valve of many species of Brachiopoda, and to which corresponds a sinus in the opposite, or ventral one. The "beak ridges," or "lateral ridges" are ridges which in certain species of Rhynchonella, etc., exist on the lateral portions of the beak, leaving a flattened or concave space between them and the hinge-line. These "lateral ridges" are either continued along the side without recurving to join the hinge-margin, or, after proceeding some distance, curve inwards to join the hinge margin. The "beak ridges," or "lateral ridges" are well displayed in such shells as *Waldheimia resupinata, W. numismalis*, etc.



Figs. 3 and 4.— *Terebratula.*

i, larger, or ventral valve; *k*, smaller, or dorsal valve; *a*, beak; *t*, foramen truncating the extremity of the beak; *r*, deltidium surrounding a portion of the foramen; *x*, beak ridge; *v*, flattened or slightly concave space between the beak ridge and hinge line; *l*, umbo or beak of the dorsal valve.

T. DAVIDSON.

FOSSIL FERN.—I have unsuccessfully searched the last number of "The Geologist" for any information concerning the interesting specimen of a fossil plant from the coal-measures of South Wales, figured at page 461 of the last volume. I am quite ignorant of the flora of the coal period; but having had some experience among recent plants, I was at the first glance led to the conclusion that the specimen is a partially developed frond of some fern. There is nothing leading us to suppose that the stem has any connection with Lycopodiaceæ. There are many species among recent ferns the young fronds of which would present precisely similar appearances. In Polystichum and Cyrtomium for instance, (not to mention other genera,) the stipes and rachis will be found quite as shaggy as in the plant figured. A partially developed frond of Cyrtomium would also present the same appearance (if pressed flat) in regard to having the pinnæ all on one side of the rachis. Older fronds upon the same plant would not appear half so shaggy, as their squamæ, or scales, are very deciduous; and two-thirds of them fall off before the frond attains its full size. The form of the whole frond shows that its vernation was circinate, another proof, if it were needed, that the plant was a fern.

I quite agree with Dr. G. P. Bevan, that we sadly need some new and comprehensive work upon fossil plants. But in the meantime the publication of such new and interesting species as the present in the pages of this magazine would greatly enlarge our knowledge of them. Our metropolitan museums would furnish ample material for such a work, if any person of note could be prevailed upon to take the matter in hand.—C. W. CROCKER, Kew.

This subject has not escaped our attention, and has already been the subject of conversation with a thoroughly competent gentlemen, whom we hope to induce to undertake the task.—ED. GEOL.

INFLUENCE OF PEROXIDE OF IRON ON ANIMAL LIFE.—DEAR SIR, the late Sir H. De la Beche, in the Mem. Geol. Surv. of Great Britain, vol. i., page 51, says, "We have made experiments to ascertain the influence of peroxide of iron upon marine and fresh-water life, and, as might be expected, the presence of this substance was found to be highly injurious to it, so that the animals quitted the peroxide of iron as speedily as conditions would permit."

Where these experiments ever put on record? If so, where? If not, can you tell me what was the nature of the experiments? Information on this subject will greatly oblige, yours truly, W. P.

REVIEWS.

The Coal-Fields of Great Britain: their History, Structure, and Duration. With Notices of Coal-Fields in other parts of the world. By EDW. HULL, B.A., of the Geological Survey of Great Britain. London: Edw. Stamford, Charing Cross: 1860.

This is a small but extremely interesting and valuable book—valuable chiefly, however, for the consideration of one topic—the duration of the produce of our coal-fields. When we look at the fact that of the ninety-five millions of tons now raised for the supply of the whole world, the British Isles alone contribute seventy-five millions; and that our home consumption also, is not only enormous, but perpetually on the increase—the vital character of the question, in a national point of view, is strikingly apparent; and Mr. Hull's statements, brief as they are, will be read with great interest even by those who are not geologists. While we have a good deal of information given us of the general character of the strata, physical geology, and fossils of our own, and the principal foreign coal-fields, in a very condensed form, all these matters are brought to bear upon the one important point—the exhaustion of our coal-mines. The results which Mr. Hull has arrived at are briefly given in his own recapitulation, and are as follows:—1. There are coal-deposits in various parts of England and Wales, all at depths down to nine or ten thousand feet. 2. That mining is possible to a depth of four thousand feet, but beyond this the high temperature will prove a barrier. 3. The temperature of a coal-mine at a depth of four thousand feet will probably be found as high as one hundred and twenty degrees Fahr.; but there is reason to believe, that by the agency of an efficient system of ventilation, this temperature may be so reduced, at least during the cooler months of the year, as to allow of mining-operations without unusual danger to health. 4. That for working mines of greater depth than two thousand or two thousand five hundred feet, underground stages, with independent winding machinery and engines, will be found not only to render very deep mining practicable, but also to lessen the amount of risk from accident. 5. Lastly. Adopting a depth of four thousand feet as a limit to deep mining, there is still a quantity of coal in store in England and Wales, sufficient to afford a supply of sixty millions of tons for about a thousand years."

In his summary of resources, Mr. Hull gives for England and Wales a total coal-containing area of three thousand seven hundred and eleven square miles which he considers may be worked to a depth of four thousand feet, giving thus a total available quantity of fifty-nine thousand one hundred and nine millions of tons. Taking the present produce at sixty millions, and allowing three millions for the increase of future years, he considers the above supply of coal will last for a thousand years; and "that for many generations to come the mineral resources of England are capable of bearing any drain to which they can possibly be subjected, either for home or foreign consumption."

For our part we are inclined to join issue with Mr. Hull, on some points—two in particular. First, we think he has underated the annual drain upon our coal-store: and, consequently, the supply he calculates upon will not last a thousand years. Moreover, we think the exhaustion will be accelerated by a much larger increased demand than the three millions of tons he allows. But then on the other hand we do not think he has admitted *all* the available store we possess. He has restricted mining-operations within a depth of four thousand feet, on account of the increase of temperature—regarded, generally, by geologists as equal to one degree of Fahrenheit for every sixty feet—and that greater depths present insurmountable difficulties for engineering operations. Doubtless, in one sense this is a right way to view the question, because as increased depth causes proportionably increased expenses, and greater cost of the material the more we should be placed at a disadvantage with respect to other nations whose coal-fields might be more accessible. When needs must, however, our engineers will undoubtedly surmount both the difficulties of mining, and find also some plan for keeping the mine cool enough for the workmen. We must also bear in mind that if the temperature increase with the depth, it does so in an ever decreasing ratio; and that from one degree to fifty feet from the surface, we have at greater depths to go seventy-five or eighty feet for an equivalent increase.

Our space, however, will not allow us to discuss these questions at length. Mr. Hull's book opens out a very important subject for consideration, and will, we trust, draw a wider attention from the public, and more detailed information from the School of Mines. Some important data have already been printed by Mr. Robt. Hunt, in his Mineral Statistics; and we hope to see these extended, and the whole subject grappled with in a manner worthy of a national institution.

Mr. Hull's book deserves attentive reading; and being inexpensive, that result ought to be attained.

On the Primordial Fauna and the Taconic System. By JOACHIM BARRANDE; *with additional Notes, by* JULES MARCOU. Boston, U. S.: 1860.

One great value of scientific research is the kinship it makes between peoples who would else know little of each other, and without it have no inducement to become better acquainted. Commerce is said—and very truly, too—to make communion between man and man, though a geographical division of a thousand leagues may part them; but the deep thinking men of any nation, if this was the only "free passport," would be shut out from participation in the great and varied benefits accruing from an extended intercourse. For they, whom "men of business" usually look upon as "half witted," and as men behind the age—"busying themselves about things unprofitable, and past finding out"—have no stake in the wide-cast net which is fast covering the earth, and drawing its riches into certain vortices of trade, to the impoverishment of the many and the enrichment of the few. So that unless rock unto rock answered as truly as American cotton does to English gold, or African ivory to Birmingham guns, the value of the highest scientific researches a man could engage in would be lost in its best and noblest sense, from being locked up within the brain that imagined it, or exported wildly, without hopes of an imported return corresponding to it in value. Science which conduces to commerce, being made subservient to the lower purposes of trade, will always be cosmopolitan in its extension, and be well thought of everywhere; but it is of theoretical geology we are now writing, and this, because it cannot be made to agree with any standard of human weight or measurement, commerce will have naught to say to. But here do not let us be misunderstood. We have never advocated theoretical geology: we do not advocate it now. The age of geological learning is too young for any theories to be put forward which aim at completeness, or that do more than indicate the position of a truth, hereafter to be found, with greater labour and pains. But deductions from known and established facts so insensibly grow into theories when they are treated of, that the utmost care has to be used by those who make studies of any branch of natural science, lest that which is hypothetical should be made to pass for a truly-based conclusion. And though the domain of the "true and established" is gaining every day somewhat of the treacherous and unstable ground of the "uncertain," and so chances of error are diminishing, yet at no time do we believe, since geology began to be studied, was there *less* taste for drawing unduly upon the steady gain of honestly-got and costly facts, or a stronger feeling among those who are building upon the strong foundation, that the wealth of what is real and true should *not* be perverted to suit a visionary scheme, or made to bear witness to what may turn out a false and deluding theory.

These thoughts have occurred in considering a certain question of great interest and importance which has arisen out of the endeavour to classify the older Taconic (Cambrian) and Silurian rocks of America. That these Taconic rocks are the representatives in the New World of the Primordial zone of Europe, chiefly developed in Scandinavia and Bohemia, is generally accepted among geologists; while the only hesitation felt is from the fact that these European "Bottom-rocks" show very scanty traces of life throughout their thirty thousand feet of thickness, whereas on the American continent they contain more than one hundred species of crustacean and molluscan life, and are indeed nearly as rich in fauna and flora as is the Lower Silurian of Europe.

In a letter from M. Barrande, of Bohemia, to M. Jules Marcou, of Boston, dated August 11, 1860, we find the passage which set us thinking how grandly one nation may become interlinked with another, through a scientific discovery of harmonies existing between the construction of the continents they inhabit. Two European lands—England and Spain—are brought into cousinship with Canada and the States, by similarity of rocks and sympathetic arrangement of their layers; for M. Barrande has reasonable grounds for his expressed opinion that the Taconic schists and limestones of Vermont reproduce in America the black shales which lie against the western flank of the Malvern Hills in our own land, and the schisty deposits which hold a similar position with regard to the Cantabrian Mountains in Spain. For though slight variations and, in the western continent, augmentation of animal life occur, yet the position in time of the beds is beyond doubt identical; and we are glad to read M. Barrande's remark "that it is a great and noble question, whose final solution will complete the imposing harmonies existing already between the series of Palæozoic faunæ of America, and that of the contemporaneous faunæ of Europe, leaving to each the imprint peculiar to its continent."

It is indeed a noble question; and while it is one that science can settle by unremitting study, her votaries need not envy the triumphs of commercial enterprise. Let that great means of spreading good, work beneath banners of success, and gather in fruits till its barns can hold no more; but still, there will be moments when labourers in the world's hive will be undazzled from the glare of their golden sun, and wish themselves with almost a sigh of regret, among those few workers who are toiling in the shade, and there building up, with materials beyond all the gold of commerce to buy, a fabric which shall be a mind-dwelling for ever!

THE GEOLOGIST.

MARCH, 1861.

NOTES ON THE GEOLOGY OF CLEVELAND.

By Charles Pratt, Esq., Oxford.

The district of which it is the object of the present paper to describe the principal geological features, has within the last few years attracted an extraordinary amount of interest and attention, as well from scientific observers as from those who are always seeking some fresh outlet for the investment of their capital. Until a period so recent as little more than twelve years ago, it was only for its fertile meadows and picturesque scenery of hill and dale, that Cleveland had gained any celebrity; but a metamorphosis so truly marvellous has since that time taken place, that it is already entitled to be associated with the most productive iron-making districts in the United Kingdom, and what, in all probability, will be its future position in that respect I shall not now venture to predict, although present circumstances would seem to indicate that, at no very distant day, the great iron-fields of South Staffordshire and South Wales must give place to their youthful opponent in the north.

The discovery, or more properly speaking, the development of the great ironstone deposits of Cleveland in 1848 has given such a stimulus to the iron manufacture of the district, and indeed, of the country, as has seldom been experienced by any other branch of trade. The present flourishing town of Middlesburgh, which, with its new environs, has a population of nearly twenty thousand, for the most part dependent on the iron trade, was, forty years ago, represented by one solitary farmstead, with a census of five inhabitants: and in like manner have all the surrounding villages in the neighbourhood of the new works and mines multiplied their former dimensions with amazing rapidity. But difficult though it be to know such facts and not seek to make them known, I must pass on from my few observations on its social geography, to what is my proper subject—the Geology of Cleveland.

The district is one of peculiar good fortune with respect to the attention it has received from scientific explorers, and the number of notices which it has called forth in various forms from those who have so investigated it. I might seem, indeed, to be performing a superfluous task in thus adding to their number, did I not feel confident that a compendious résumé of the chief points of interest will prove acceptable to many, even of those who have kept pace with all that has hitherto been written on the subject. Much of what I shall say has, doubtless, in one shape or other been said already; but I shall say little which I have not proved by personal examination on the field, and at the same time shall correct some errors which I have discovered in the remarks of some of those who have preceded me. For a more elaborate account of the history of this district, and for more extensive sections and analogies than I here am able to give, I may refer the reader to a very valuable paper read by Mr. John Marley, C E., before the Society of Mining Engineers, at Newcastle, and published in the fifth volume of the proceedings of that excellent society. A voluminous monograph has been very recently brought out on the Cleveland ironstone, which contains much valuable information. The writer, however, evinces a want of comprehensiveness in his general ideas of geology; and the volume, besides some inaccuracies, contains so much which can only be of interest to the writer himself, that I regret my inability to commend it, either as a literary production, or as a scientific manual remarkable for brevity and perspicuity. To other volumes and notices I shall give reference as I proceed; although I may mention that, to Professor Phillips in particular is due the merit of having been the first, and I need hardly add, the ablest investigator of this interesting portion of Yorkshire.

The whole of Cleveland may be divided into the great plain, or lowlands, and the hill-country, or highlands; the former of which is to a great extent surrounded and abruptly determined by a noble range of hills, varying in altitude from one thousand to one thousand five hundred feet, and which gives the whole scene the appearance of a vast natural amphitheatre.

Before I proceed to a descriptive account of the various strata, it may be well to make a few observations upon the most striking physical features, and the theory by which they are accounted for. No one who has visited the lovely dales with which the south-east of Cleveland is adorned can have failed to have been struck by the gentle acclivities, the curiously-shaped "nabs," and the noble escarpments, which alternately present themselves to the view; and most observers, doubtless, who have thought of the matter, have in their own minds fixed upon some actionary cause for all the pleasing diversifications of scenery. To most, probably, the watery element at once presents itself as the most familiar cause from which such a result could flow; and by some I know, the tiny stream, which sluggishly meanders through the vale, has been dignified by being made the agent of the metamorphosis. If, however, we consider the portion of the strata at various points, the different angles and directions of declination at which we find them, we arrive at once at the conclusion that aqueous action can only be referred to as the means of having modified the superficial irregularities which had previously been occasioned by a more powerful—a subterranean agency,

That the Oolitic and Lias formations have obtained very much further in a north-westerley direction—how much further I see no data for ascertaining—their steep escarpments and abrupt termination towards that quarter most clearly evidence; and that the present inclinations of the strata, dipping as they may be found to every point of the compass, have been acquired subsequently to their formation, is only in accordance with the great principle of horizontal deposition. The *general* dip, however, of the strata is towards the south-east.

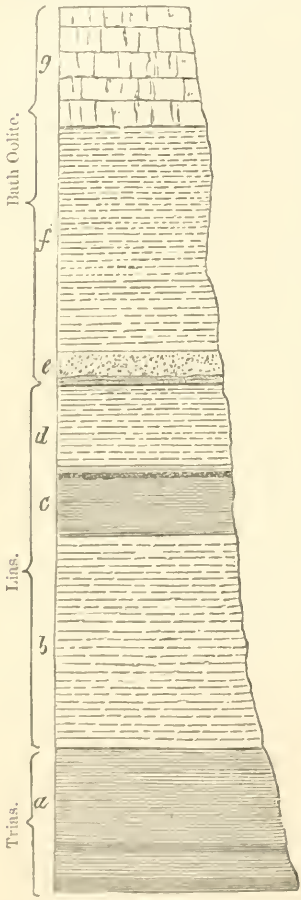
The tremendous convulsion which raised the great Penine Alps of England—that subterranean convulsion which uplifted the mountain limestone to a height of a thousand yards through a length of nearly seventy miles, which, in all probability, broke the continuity of the Yorkshire and Newcastle coal-fields, and which is justly termed one of the most magnificent examples of dislocation in Europe.—This stupendous disruption, I say—to which we may refer so many phenomena—may be regarded as the probable cause of much which may not otherwise be easily accounted for in the physical aspect of Cleveland.

How vast and potent must have been the oceanic currents, which caused the denudation of so great an extent of strata! But, upon the fractured edges of the dislocated strata, the violent action of the waves and currents would exercise a wondrous wasting and excavating power. Here, then, we have causes sufficient for the changes we observe; but, whether the actual efficiencies in operation, is a question for others to decide.

The rivers, as Professor Phillips observes, run from the north part in valleys which the sea made for them: the gradual wasting, through atmospheric agencies of the shales below has caused the superincumbent solid rocks to fall away, and crumble in their turn.

If we follow the course of the North Yorkshire Railway we shall see at a glance some of the instances of dislocation to which I have referred above. A little more than a mile eastward from the village of Kildale we notice the sandstone rock of the Inferior Oolite (which I shall hereafter call the "Bottom Sandstone rock"), a few yards only above the level of the valley on our right hand, going eastward; whilst, on the left towards Weyworth, it caps the summit of the valley at a very considerable height, and is easily traced descending very rapidly, as far as Commondale Station. At Castleton, which stands upon this same Sandstone rock, a very considerable dislocation is easily observed, which extends to a great distance eastward, and becomes more and more apparent where the vale of Danby is narrower, as at Danby Crag and Howlsike. The Esk here runs in a synclinal axis of the strata, as is most clearly discernible in Crunkley Ghyl, to which I shall have occasion to refer hereafter.

Before I proceed further with my notes, it may be as well to give a tabular section of the various strata as exhibited in this district, preparatory to their minute division and explanation. It will be observed that they are confined to the middle and lower divisions of the great Mesozoic series.



Although I have endeavoured to show in my section the comparative thickness of the several divisions, we shall find that they vary very considerably in the extent of their development at different parts of even the small district under our present notice.

The following may be understood as a general view of the series:

g, Impure limestone, with shales, sandstones, &c., above 200 feet.

f, Shales, sandstones, ironstones, with fossil plants and thin seams of COAL—500 feet.

e. Sandstone and ferruginous beds —70 feet.

d, Upper Lias shales—200 feet.

c, Ironstone and marlstone series —150 feet.

b, Lower Lias shales—500 feet.

a, Poecilitic gypseous marls.

I shall now proceed to examine the various beds of which these series are composed, taking them in the order of their deposition.

a, It is only the extreme western and north-western part of Cleveland where we find the lowest division of our section apparent on the surface, and where, in fact, it forms the extreme northern termination of that long continuous New Red belt, which has one extremity in the rich vales of Taunton and Exeter, and its other in the broad estuary of the Tees. It is most easily seen in the district under notice, on the banks of the Leven and other smaller streams near Hutton Rudby, although I am not aware that its thickness has ever been accurately ascertained. A short distance below the village, the whole bed of the picturesque Leven is paved with the ripple-marked shales, which are so general in this part of the series. To the geological student of vivid imagination, how strange to stand upon these rippled beds and call to fancy's view the scene which, æons upon æons ago, was there presented, before the mountains he now sees before him were brought forth, or ever the hills around him formed!

To sink through part of these shales and all the intervening strata to the coal formation below has been, as we need hardly wonder at, long a favourite project with the landed proprietors upon whose estates they crop out to the surface; but, whether a consummation so devoutly to be wished, is ever likely to be realised, is a question which may well be doubted. If we consider the inclination of the seams at the southern extremity of the Durham coal-fields, (which is about twenty miles north of the district of which we speak, and the possibility of the attempt being made at a point where the coal attains a low depth in the fault (as we know the Lias is seldom conformable to the carboniferous series): and, moreover, if we think of the doubt which may reasonably be entertained as to whether the coal-measures do actually underlie the Lias of North Yorkshire or not, and the great depth to which must in any case be sunk before the question can be pronounced to be finally solved, I cannot certainly hold out any hopes that for many years to come Cleveland will be reckoned amongst the coal districts, or that ever a trial will be made with a result to satisfy all, who are either scientifically or pecuniarily interested in the matter. Although the search for coal has so often proved unfruitful, yet the dim prospect of such a rich mine of wealth does so easily beguile the landed squire, that it seems an idea which the personal experience of an attempt to realize this fond hope alone can banish from his mind. And if we believe Sir Roderick Murchison,* amid all their failures we never meet with an individual who is really disheartened; but a frequent exclamation is, "Oh, if our squires were only men of spirit, we should have as fine coal as any in the world!" An attempt was recently made on the estate of Visount Falkland, of which I cannot refrain from speaking in anything but terms of commendation—since the abandonment at a depth at which few would look for any result more than has been arrived at, has done nothing towards setting the question at rest. Its continuance, if persisted in. should be a matter for public, rather than private expenditure. As regards the gypseous marls of which we were speaking above, there seems nothing of sufficient interest in them to detain us longer in our examination.

b, The Lower Lias shales obtain over most of the plain or lowlands of Cleveland, and are seen to a considerable height in most of the escarpments of the long range of hills. These beds, which we may safely estimate at five hundred feet in thickness, consist for the most part of a dark homogeneous indurated clay or shale, sub-calcareous bands and layers of ironstone nodules, which are too much inconsiderable to be worked for profit, although when found on the shore, loose from and washed out of the surrounding shale, they have been shipped in small quantities for the furnaces on the Tyne. An excellent natural section of the upper part of the Lower Lias is visible on the Cleveland coast at Huntcliffe, and inland in the steep ravines on the

* Silurian system, part i., p. 328.

north side of Carlton, or, more properly, Dromonby Bank. In some parts, it it is very abundant in organic remains, and contains whole rocks which are little else than a congeries of extinct molluscs the *Gryphæa incurva* being one of the most familiar and characteristic. No part of the Lower Lias has ever in this district been wrought for economic purposes. From this we proceed to one of the most important divisions in that respect, namely—

c, The Ironstone or Marlstone Series.—The lower part of this series, which we may estimate at a total of one hundred and fifty feet in thickness, consists of alternations of shale, marlstone, and sandstone, of a soft and argillaceous character, generally abundant in fossil reliquiæ, especially in *Belemnites*, *Ophiuridæ*, and *Cardium truncatum*, and partially ferruginous. A good section may be obtained at the same points as I referred to in the last division, and the marlstones may be well seen in the prominent edges which they form in the far-famed Roseberry Topping, at the east end of the Wainstones Bank, and many other elevations.

It is, however, to the great ironstone-band, which forms the highest stratum in this series, that this district owes all its celebrity as an iron-producing country, and in respect of which we may truly say, it is a "good land, and a land whose stones are iron." The seam was first developed in 1848, in the picturesque hill of Eston Nab, where the yield may be calculated at about fifty thousand tons to the acre. The following detailed section is from a communication by Mr. John Marley, C.E., to Professor Phillips:—

	ft.	in.	ft.	in.	ft.	in.
Ironstone—top block, left as roof ...	0	11				
(parting)						
Ironstone—second block	2	3				
(parting)			17	0		
Ironstone—main block	12	0				
(parting)					32	6
Ironstone—bottom block, (variable)	1	10				
Shale	7	0				
Ironstone-band	1	8	15	6		
Shale	6	0				
Sandstone-band	0	10				

The above gives a solid mass of ironstone rock no less than seventeen feet in thickness! This is, however, the point at which we find its greatest development, since at Grosmont, near Whitby, the same series is found in this altered and divided state:—

	ft.	in.
Shale	0	0
Ironstone—"Pecten-seam," in two bands, separated by one feet six inches of shale	4	0
Shale	4	0
Ironstone—good	1	0

	ft.	in.
Shale	7	0
Ironstone—good	1	6
Shale	18	0
Ironstone—"Avicula-seam"	4	0
	38	6

In the Grosmont district, however, as I shall have occasion to mention hereafter, the inferiority of these seams to their thickness at Eston is compensated by the presence of other seams above, which are not similarily developed at Eston Nab. The extent of country over which the Cleveland ironstone bands extend cannot be estimated at less than two hundred square miles, capable of producing from twenty thousand to nearly one hundred thousand tons an acre. The present total yield of Great Britain is something like three and a half millions of tons of iron, from (say) thirteen million tons of stone. Although Cleveland was not worked until 1848, its produce is estimated at six hundred and thirty-three thousand tons of pig-iron from near two million tons of ore. From the extensive mines at Eston alone the vast quantity of two thousand six hundred and twenty tons nineteen hundred weight has been wrought in one day,—thirteen thousand four hundred and-seventy four tons in a week,—six hundred and thirty-eight thousand six hundred and twenty in one year; and a total during the past ten years of four millions sixty-one thousand nine hundred and eighteen tons.

This ironstone is chiefly a carbonate of protoxide, of a greenish grey colour, and yields by government analysis thirty-three per cent. of metallic iron,* although the average should probably be given at about thirty per cent. The following is what is generally requisite to the manufacture of one ton of pig-iron:—ironstone (calcined), two tons twelve hundred weight, or uncalcined, three and a half tons; coke, one ton fifteen hundred weight; coal, one ton; limestone, fifteen hundred weight. What countless tons of iron, therefore, may be extracted from the vast beds of Cleveland—sufficient to supply, for hundreds of years the whole demand of the British Isles!

In every direction from the maximum thickness at Eston, we find the seam grows gradually thinner and thinner, especially towards the south-west, where it may be said to die out at Thirsk. At Swainby also the seam is reduced to about four feet, and divided by rather more than a foot of shale. The seam at Eston is formed of a compact coalition of what are found in other parts as two distinct seams, parted by as much as nearly thirty feet of shale at Grosmont, and the eastern extreme of Cleveland; the upper of these two seams, as in the Grosmont section, is designated the "Pecten seam," from the vast number of pectines *(Pecten æquivalvis)*, which are found in it; and the lower the "Avicula seam,"

* See appendix.

owing to the abundant remains of *Avicula cygnipes* in it. Towards the east the "Pecten seam" acquires more the concretionary spheroidal form, as usual with argillaceous deposits, and approaches nearer in appearance to the hard, compact clay-stones of the coal-measures at Bierley and Low Moor. As the diminution in thickness towards the south-east and west from Eston is very gradual, it is impossible to fix any line of demarcation to point out the exact boundary within which it is of sufficient value to be worked.

An interesting paper was read by Mr. H. C. Sorby, F.G.S., before the West Riding Geological and Polytechnic Society,* in which the writer endeavoured to show that the Cleveland ironstone was altogether an altered limestone-rock, in which the carbonate of lime had been changed to carbonate of iron, by the percolation, probably, of some chalybeate water, and that the ironstone was not deposited in its present condition. I confess that I am not inclined to adopt those views without further examination, as I think the whole analysis of the ore does anything but favour such a theory. In concluding my notice of this most important division, I need only add that these Lias bands are very extensively wrought, at Eston, Upleatham, Codhill, Hutton Lowcross, Belmont Banks, Rosedale† on the coast, Grosmont in Eskdale, and several other parts of Cleveland. The usual royalty-rent paid in the district varies from fourpence halfpenny to eightpence per ton of twenty-two and a half hundred weight; and, so cheaply may it be worked, that it can be sold with profit at half-a-crown a ton at the mine's mouth. Such brief statistics may be of interest to those readers who are in any way connected with this great branch of manufacture. I now ascend to

d, *The Upper Lias Shales*, which also possess great importance in an economic point of view. After about thirty to forty feet of hard sandy shale, which is the lowest rock in the upper Lias, we find what is generally called the "Hard Jet Rock," a variable shale twenty feet in thickness, enclosing irregularly jet and pyrites. On the coast, as at Kettleness, the rock is harder and more productive of jet than in the interior of the country: the raw material is, according to quality, worth from two shillings to twelve shillings per pound, and the total value of the jet-manufacture at Whitby, whither it all goes from this district, is estimated at twenty thousand pounds per annum. Owing to the great quantity of iron-pyrites, or nodules of sulphuret of iron, which these shales contain, it not unfrequently happens that upon being dug out in the search for jet, and exposed to the action of moisture and the atmosphere, the sulphur combines with the oxygen of the air and of the water, and in this decomposition sufficient heat is generated to cause spontaneous ignition. An instance of this decomposition occurred not long ago in Westerdale, and caused no little wonder amongst the homely inhabitants; it is, however, of

* Report of Society's Proceedings, 1856-7, p. 457.

† There are two "Rosedales" in this district celebrated for their ironstones: one near Staith on the coast, and the other fifteen miles inland.

frequent occurrence on the coast at Runswick Bay. Here, it is scarcely necessary to remind the reader, is a most marvellous profusion of Ammonites, Belemnites, &c., and an abundance of the now familiar remains of Ichthyosauri and Plesiosauri. An excellent section of these rocks, and a delightful field for geological observation, will be found in the quiet and picturesque bay of Runswick. Above this jet-rock are about eighty feet of shale with ferruginous nodules, irregularly interspersed, and for the most part aggregated round Ammonites and other organic bodies. Being very compact and argillaceous, they closely resemble some of the clay-ironstones of Derbyshire, and claim a similar, though far from a synchronous origin. Above this shale, again, we reach the fine argillaceous deposit so well known by the name of "alum-shale," which is from eighty to one hundred feet in thickness, and has been worked for the manufacture of alum since about the year 1594, when alum-works were first introduced into the district of Guisborough, by Sir Thomas Chaloner, where these shales have ever since been more or less extensively wrought. Scattered up and down through the whole length of Cleveland, we find traces, in vast heaps of calcined shale and large excavations, of abandoned alum-works, as at Carlton Bank, Kirby Bank, above Great Ayton and several other places, whilst we find in present operation the works near Guisborough, at Boulby, and at Kettleness. The process of manufacture is simply as follows: the decomposition of the shale is accelerated by being burnt in large heaps by the manufacturer, who avails himself of the carbonaceous character of the shale, and the sulphur of the iron is changed into sulphuric acid, which forms a sulphate of iron and alumina; by subsequent processes of evaporation, the sulphate of alumina is purified, and potash is added to render the salt crystallizable.

Above the alum-shale is a stratum about twenty feet in thickness, which is usually termed the "Cement-rock," from its containing numerous calcareous nodules, which are used in the manufacture of Roman cement. These nodules will, for the most part, be found to be an aggregation round an organic nucleus; and by baking them until they divide, I have frequently procured most beautiful specimens of fossil Ammonites. Above this is found, in a perfect section, a deposit of about four feet of indurated clay known as the "soft jet-rock," from its containing a quantity of jet, inferior however to that in the hard jet-rock, of which I spoke before. This rock, in opposition though it be to many, I shall make the highest one and the conclusion of the Lias formation, the upper division of which, as I have described it above, may in summary be given as follows:

		ft.	in.		ft.	in.
Soft jet rock	about	4	0			
Cement-rock	,,	20	0			
Alum-shale (used in manufacture of alum)		80	0	to	100	0
Alum-shale (*not* so used, and with many nodules)................................		60	0	to	80	0
Hard jet rock		18	0			
Hard sandy shale...		20	0	to	40	0

The deposition of the Oolitic and Lias formations, unlike that of the Coal-measures and New Red Sandstone, was evidently continous, and is without any traces of an interval elapsing between. In proportion, therefore, as we find the transition from one to the other more gradual and undefined, we may regard the section as more perfect and complete. At the head of Fryup Dale, for example, we find the transition line far less marked than at Roseberry and most other places; and therefore we may assume that it is a more perfect section than the others. The basement-bed of the Inferior Oolite has, in the south of England, been the object of a contest between Dr. Wright on behalf of the Lias, and Professor Buckman for the Oolites, as may be seen in a paper read by the latter before the Geological Society.* I shall, however, here content myself by merely stating that there are reasons, which I cannot now spare space to adduce, for regarding the next important stratum, as it sometimes appears as the lowest member of the inferior Oolite.

c, There is no bed amongst all which I have described, which varies so much in so short a distance, as the lowest bed of the division which I have before termed the "Inferior Oolite and ferruginous beds." They give an aggregate of about seventy feet at many points in the district. This is, at one place a vast iron-rock of thirty-two feet in thickness, and at another a mere silico-ferruginous mass of no commercial value. At many places, as for instance at Eston, Hutton, Lowcross, Fryup, and Grosmont, its importance may be said to be almost in inverse proportion to that of the lower, or "Pecten-seam," in consequence of its being geologically higher up than the other seam, which is often called the "Eston-seam," from having been first opened out near a village of that name: this band we now speak of is commonly called the "top seam," although improperly, as a higher one still has been wrought. The "Oolitic seam," as I shall now call it, is worked on the east near Staithes, and at Beck Hole in the Grosmont district, and at Rosedale in the interior of the country. Near Staithes it assumes a compact and argillaceous appearance, and is at the best part about four feet thick. At Beck Hole it is not less than fifteen feet thick, and has a more open and oolitic structure, and in appearance more resembles the Lias seam at Eston. At Rosedale its character is again changed, and it has become a vast oolitic iron-rock thirty-two feet thick, attractable by the magnet, and yielding, as a maximum, nearly fifty per cent. of metallic iron. To develope this invaluable deposit, a line of railway is now being made across the moorland heights, from near Ingleby Greenhow on the North Yorkshire Railway—a distance of about ten miles. To account for, if I may use the term, the metallic richness and the great thickness of this Rosedale iron-rock, has long been a puzzle to many of the local geologists, who have thought its value and extent less than some anticipate. At the quarry, indeed, where most have observed it, and where it was primarily opened out as "metal" for the roads,—rich

* Proc. Geol. Soc., Quarterly Journal, vol. xii., p. 292, and vol. xiv., p. 98.

metal too, it appears—the seam assumes such an aspect as might deceive many; since owing to the percolation of water through the countless cracks and fissures at its outbreak, the iron has become oxidised gradually more and more; and where not quite oxidised throughout, the blocks consist of a nodule in the middle, of almost unaltered dark blue ore, of nearly equal parts of protoxide of iron (about thirty-three per centum where richest), and peroxide of iron (about thirty-two per cent.), and several concentric layers of brown ore, the outer of which contains all the iron in a peroxide state, and clearly showing a change to have taken place from a protoxide to a hydrated peroxide. In the drift made a little eastward of the quarry we find, after eighty yards of hard shale, other eighty yards of the altered brown ironstone, with blue nodules, which increase in size as we proceed, until at last we reach the solid rock, unaltered by any percolation; intensely hard; of a blackish-blue colour; highly magnetic; lying in horizontal layers; scarcely fissured, and thirty-two feet in thickness. A considerable distance from this drift it has been twice bored down to, at a depth of forty-five fathoms, and proved still of the same great thickness: although its per centage will probably average less than has been given above, there seems no reason to fear that the seam will soon be exhausted. Some have thought that this rock exhibited symptoms of igneous origin; others have made it out to be affected by heat, subsequently to its deposition; and some have even tried to trace a cause-and-effect—a connection between the Whin-dyke, seven miles away, and this astonishing stratum of iron-ore. There is however not the slightest foundation for any such surmises, as we find it in a horizontal position, in distinct laminæ, between the upper Lias and sandstone-rock of the Inferior Oolite,—most assuredly the natural place of its deposition. The depositing waters were greatly impregnated with oxide of iron, which congregated round any solid object; and accordingly in each oolitic particle, there is some nucleus of shell, sand, &c., which is perceptible under the microscope, as in oolitic limestones, in the interior of each of the grains. There have, I believe, been no organic remains discovered in the rock, owing, it is possible, to part of the iron being in the peroxide state—in which case it is a noticeable fact that there is either very great scarcity, or an utter absence of traces of animal life. Whether, however, these two facts, so generally coincident, are related as cause and effect, is a question for further consideration. The Lias iron-seams, which contain the iron in a protoxide state only, show the ocean at the period of their deposition to have been very prolific in organic life.

An interesting view of this oolitic iron-seam may be obtained by tracing its development from Crunkley Ghyl up the eastern side of Great Fryup Dale to Fryup Head, and again to its appearance in Northdale, on the other side of the moor, and opposite to the great iron-quarry of Rosedale, which I have just remarked upon, and where, as I observed, the seam appears to attain its maximum thickness and to possess also its maximum dose of iron. The outbreak of the seam has, owing to the decomposition of the iron, a reddish-brown appearance; and, where sufficiently rich in iron, shows the usual "scrappy" layers, or envelopes, owing to the percolation of water. This is very noticeable at Fryup Head, where the seam is of great thickness.

I now pass upward to the "bottom sandstone rock," of which I spoke before, and which is the great and safest guide in searching for the ironstone strata. It runs along the summits of the sides of most of the Cleveland dales, and has been used very generally in the district for building purposes. At Sleights, near Whitby, it has been extensively wrought for local use, as also for shipment, and is in fact the great building stone for the whole of Cleveland. It caps most of the chief hills, or "banks," as they are called in the district, crowning the summit of Roseberry Topping, Easby Bank, &c. The excellent state of preservation of the stonework in the ruins of Guisborough Abbey, and Mount Grace Priory, attests the durability of the rock.

I now come to the next division in my section (*f*), which it would be difficult to subdivide in such a manner as to be equally applicable to all parts, where the rocks contained in it crop out to view. Above the bottom sandstone rock, however, are alternations of shales, thin iron-bands, and gritty sandstone layers, about sixty feet in total thickness. We then come to a vast series of sandstones and shales of various colours and thicknesses, and amongst them are some seams which demand a short notice. In this series we find a variable stratum of fire-clay, which is well seen in the excavations of a recently-formed Fire-clay Company at Skelderskew, in Commondale, where it is of considerable thickness, and, it is also stated, of great commercial value. Embedded in an impure sandstone bed above this seam are found vertical Equisetites, in great abundance—the *Equisetum columnare*. Higher up, amidst the countless beds of shale and sandstone, we find a thin seam of coal, of sufficient importance however to be worked for local use, although the thickness is never more, and sometimes a few inches less, than sixteen inches. This seam, which is accompanied by fossil plants in the shales above and below, is similar to one discovered in the same oolitic series of Brora, in Scotland, and worked from the patriotic—certainly not pecuniary—motives of a late Duke of Sutherland. In the North Yorkshire district it is worked at Rosedale Head, Danby End, and, until recently, at Great Fryup Head. It may be seen out to the day on the side of the road from Castleton to Guisborough, about half a mile from the former place; and in the hill as you ascend to Danby Beacon from Howlsike. An acre of this moor-coal is generally estimated to contain about two thousand chaldrons of thirty-two bushels. The appearance of this carboniferous deposit has not failed to excite hopes in some whose scientific knowledge, it need hardly be said, is like the coal-seam—limited: that by going further down, better, or—as some even think—the Durham coal-seams will be discovered. Although men seem born with the "only-go-deeper" notion in their heads, it seems unnecessary to remark, that any hopes of finding coal superior to that now worked, are entirely without other foundation than the above instinctive notion.

I had almost forgotten to mention another seam of iron-stone amongst these higher strata, which has a more argillaceous aspect than the others, though its thickness is less considerable. It is, as all the other strata, of anything but uniform thickness; and at present the only place where it has been fully explored and worked to any extent is at Burton Head, near Ingleby Greenhow. It has, I believe, also been worked at Raithwaite, near Whitby. At Ingleby mines the stone was found to obtain in three bands, with shale intervening, giving a total of rather more than four feet of iron-stone, and two and a half of shale between. These mines, however, are for the present abandoned, although a great sum has been laid out on an incline-plane, and other preliminaries to active operations.

To anyone who is familiar with the section of the Bath Oolite, in the south of England, it must be at once apparent how different are the analogous beds, in the district which I have been describing. This last great division (*f*), is isochthonous with the Fuller's-earth group of Bath, although we can see so little similarity in their components.

g, The last division in my section is the earliest wherein is any trace of a limestone rock; and its aspect in Commondale, where we see it most easily, bears little or no resemblance to the type of an oolitic limestone. It is very much debased by an admixture of silica, iron, and other extraneous matter, which causes it to be of little value for agricultural purposes. So little indeed is it regarded as a limestone, that it has long since ceased to be burnt for any purpose; and whilst it was regularly burnt formerly at the kilns on the high moorland above Commondale, great care had to be taken lest it should run into a flux from too intense a heat. Although as a limestone its value can never be considerable, yet if silica were required with any argillaceous ironstone to help to form a clay, it might probably be of service to any furnace near where it exists: as such however is very improbable with most of the Cleveland iron-seams, we can only wish it had been more calcareous. I append an analysis of this seam as at Commondale, made by Prof. Henry, who gives a much more favourable one than appears in Prof. Phillips' "Geology of Yorkshire."

Above this limestone is another very thick series of sandstones, shales, &c., very similar to those in group *f*, of which I have often spoken. As they present little that is noticeable, I shall not attempt to examine them, although we find them occupying some of the highest ground in North Yorkshire, as at Danby Beacon and White Cross. With this notice I shall conclude my observations on the sedimentary rocks, and proceed to make a few remarks upon the only igneous rock which we find in the district—the well-known basaltic dyke, which has been termed "one of the most remarkable phenomena of English geology." It extends in almost a straight line from Cockfield Fell, in Durham, to Maybecks, in the east of the North Riding—a distance of seventy miles. It is unaccompanied by any dislocation, and its only visible effect is the charring of the coal, which it divides in Durham, and the ordinary results of intense heat upon the contiguous shales, limestones, and sandstones. Its width is from seventeen to about sixty feet, and is greater in the middle than at its two extremities. Its depth, it need not be added, is unfathonable. When unaltered by weather it is of a dark blue colour; but owing to the iron which it contains, the outer portion becomes rusted upon exposure, and exfoliates like an ironstone. An excellent view of this "frolic of nature," as it has been called, may be seen in a cutting which the railway has made through it near Castleton, and its caustic effects on the bordering strata for a very short space on each side, and total absence of dislocating fracture may be clearly observed. Owing to its intense hardness, it is of invaluable utility as a material for the roads to a great distance on each side of it, for which it would otherwise be a difficulty to find a stone sufficiently durable. It is, and when the proposed lines are completed will be much more, extensively wrought, and sent to a great distance to pave the streets of several of our large towns.

There are many instances of alluvial deposits, and many isolated granitic boulders at the foot of Carlton Bank, at Lealholme Bridge, and other places, which I cannot now stay to remark upon. With reference to the vast superficial accumulations of peat at Danby End and other places, I shall quote an extract from a work published about eighty years ago,* as an illustration of a geological theory at that period, and at the same time to impart a piece of interesting information for any "Judæus Apella" of the nineteenth century: "Hazel-trees and nuts with kernels in them are found in our peat-bogs, covered up most probably by the deluge; and I cannot help observing here, that these nuts prove to a demonstration that the flood of Noah happened in the autumnal season of the year, and most probrably in the month of September, when it is known that kind of fruit is always ripe with us here in Yorkshire."

I may here observe before, before I conclude, that there are traces to be noticed, at Furnace Farm, near Fryup End, in Commondale, at Castleton, and other places, of the rude manufacture of iron in ancient times. At the above places are large heaps of scoriæ, from which the metal has been but imperfectly extracted, and amongst which I have found pieces of the metal itself. These primitive iron-masters, who lived most probably in monkish times, seem from the small pieces of ore which I have found to have merely collected the loose boulders; or outside pieces of the thin rich nodular bands, and, of course, used charcoal only, as may abundantly be seen, in their reduction to a fluid state.

It now merely remains for me to express my regret at not being able within the scope of this essay to dwell, as I should greatly have wished, upon the characteristic and other fossil-remains of the several groups; and to express the obligation I am under to the

* Hist. of Whitby;" by L. Charlton: 1779, p. 353.

works of Professor Phillips,* who has devoted much time and attention to the geology of this interesting district, which my observations will, I think, abundantly prove to be one of great fascination to the man of science, and of great importance in the national economy.

Analysis of the Cleveland Ironstone (Pecten-Seam), by Prof. Percy.

Protoxide of iron	39·92
Peroxide of iron	3·60
Alumina	7·86
Lime	7·44
Magnesia	3·82
Silica	7·12
Carbonic acid	22·85
Other substances in small quantities	7·39
	100·00
Metallic iron	33·62

Analysis of Dark-Blue Magnetic Ironstone from Rosedale, by W. Crowder, Esq.†

Protoxide of iron	33·55
Peroxide of iron	31·40
Alumina	16·05
Lime	2·35
Magnesia	1·29
Carbonic acid	10 26
Silicic acid	4·50
Water	1·34
	100·74
Metallic iron	48·07

Analysis of Commondale Limestone, by Prof. Henry.

Carbonate of lime	44·8
Silica	51·4
Alumina and oxide of iron	2·6
Water, &c.	1·2
	100·

* "Manual of Geology;" "Geology of Yorkshire," part i.; "Mountains and Rivers of Yorkshire;" "Oolites of Yorkshire," in Geol. Quart. Journ., vol. xiv.

† Edin. New Philos. Journ., Jan. 1857, p. 40.

ON NEW BRACHIOPODA, AND ON THE DEVELOPMENT OF THE LOOP IN TEREBRATELLA.

By Charles Moore, F.G S.

(*Continued from page 445, vol.* iii.)

Thecideum. Defrance.

Thecideum ornatum. Moore. Pl., ii., figs. 1—3.

Shell inequivalve: punctuate, rather rugose, front deep, rounded; attached by a considerable portion of the ventral valve; beak slightly incurved; deltidium small and depressed. The ventral valve is flattened on its under side. Its interior is surrounded by an elevated, slightly granulated margin. Under the deltidium are seen two raised oval processes, separated by a longitudinal septum, which occupies the greater length of the shell. The exterior of the dorsal valve is rugose and flattened. The interior possesses a narrow, thin, punctuated margin, immediately succeeding which is a ridge of single granulations, which are stronger towards the frontal margin, gradually disappearing as the ridge passes upwards. Springing from the centre of this granulated ridge is a septum, slightly tapering from its base, on either side strongly serrated, between which is a central longitudinal groove. The septum occupies nearly the whole height allowed by the cavity of the shell, and divides it to nearly three-fourths of its length. From the top of the septum there are thrown off two extremely delicate lamellæ, forming a loop which curves downwards towards the front of the shell, where they bifurcate, and are then again united to the shell at its inner sides. Above the septum and attached lamellæ a band occurs, forming a bridge over the visceral cavity. This is united to the granulated ridge, which thus completely surrounds the inner portion of the valve.

Obs.—The preservation of the loop as shown in the enlarged fig. 3, plate ii., is remarkable, since in the original specimen it is in substance scarcely thicker than the finest unspun silk, and extremely brittle. The interiors of the Brachiopoda are only to be developed by careful manipulation in dissecting or opening up the valves. Many of the interiors of the Thecididæ are very beautiful; but I have never as yet seen any species equalling in delicacy of structure that under consideration. It is from the Coral Rag of Lyneham; Wilts, where it is not uncommon.

Thecideum pygmæum. Moore. Pl. ii., figs. 4—7.

Shell microscopic, longitudinally oval; both valves convex; attached to other bodies at the upper part of the ventral valve; beak slightly produced; area short; deltidium ill defined. A thin raised ridge passes round the front and sides of the dorsal valve, until it reaches the dental sockets. It is without a central septum, nearly always present in other species, the only ornamentation within the ridge being numerous punctuations.

Obs.—This shell is very numerous in the Coral Rag of Lyneham, associated with the *T. ornatum* and the *T. triangularis.* I have been unable to trace any passage into either of the above species, otherwise it might have been considered a young stage of one of them. As it is altogether different in character, and as the shell, though so minute, is very persistent in its form, I have ventured to give it the above specific designation.

Thecideum triangularis. D'Orbigny.

This species has hitherto been noticed only in the Middle and Upper Lias and the Inferior Oolite. I have now obtained it from the Lower Lias of Keynsham, which is the oldest formation in which it has yet been found. It then passes through the beds above mentioned, and is very common—attached to Lima, Ostrea, and other shells—in the Fuller's Earth of Combehay, near Bath. It occurs also in the coralline bed of Hampton Cliffs, and again in the still higher zone of the Coral Rag of Lyneham. No other species of Brachiopod has yet been known to have attained so long a range as is indicated by the above facts. Its uninterrupted passage through so many formations points out the absence of any considerable climatal or other changes during the deposition of the beds in which it is found.

I have evidence of the presence of several other species in the Inferior Oolite of Dundry, one very nearly approaching the *T. Deslongchampsii*, Dav.; but as only separate valves have been found, it will be unsafe at present to say more respecting them.

Crania. Retzius.

Crania canalis. Moore. Pl. ii., figs. 8—10.

Shell subquadrate, usually flattened, at other times more or less conical. The outer surface of the young shell exhibits a few coarse striæ, which continue to the margin of the valve. In the adult these become much more numerous, many of them passing as narrow spines, some distance beyond the outer margin of the shell. The interior of the valve is concave, showing two pairs of muscular impressions, not strongly marked; the anterior pair curving upwards towards the posterior, which are rounded and larger. When viewed from the inner side the valve is seen to be surrounded by a flattened ridge, which is continued outwards in long spinose expansions, which are furnished with narrow longitudinal grooves, or canals, through the whole of their length.

Obs.—This is one of the most beautiful species of this interesting genus of shells. It is from the raggy beds of the Inferior Oolite of

Dundry, which have furnished me with so many new forms of Brachiopoda. The upper valve only is known.

Crania Saundersii. Moore. Pl. ii., figs. 11, 12.

Shell rounded; exterior of the valve flattened, or slightly convex; surface wrinkled; shell-structure smooth. The interior of the valve shows four muscular impressions; the upper pair being rounded and depressed, the anterior, occupying the middle of the valve, are raised and prominent, ear-shaped, and curved outwardly.

Obs.—By its exterior it would be difficult to distinguish this shell from the *C. antiquior* of the Great Oolite of Hampton Cliffs, but the interior of the valves differ. In the *C. Saundersii* the two pairs of muscular impressions are more widely separated, the lower pair being much stronger, and in shape different from those of the *C. antiquior*, and there is also the absence beneath them of a longitudinal ridge usually present in the latter shell.

It is from the Inferior Oolite of Dundry, near Bristol. I have much pleasure in naming it after Wm. Saunders, Esq., of Clifton, to whom the Museum of the Bristol Philosophical Institution is so much indebted. The shell also occurs in the Inferior Oolite of Minchinhampton, Gloucestershire.

Crania Ponsortii. Eug. Deslongchamps. Pl. ii., figs. 9, 10.

The shell described under the above specific name was found by M. Deslongchamps in the Great Oolite of St. Aubin. It occurs in the coralline beds of Hampton Cliffs, and with it the *Crania antiquior* of Jelly is found in great numbers. The outer surface of the latter shell is characterized by possessing a somewhat rugose, or wrinkled surface, and the interior by its well defined muscular impressions, which always occupy the same position in the species, and give pretty uniformly the same pattern to the interior. The interior of *C. Ponsortii* appears to be undistinguishable from it, the chief difference being in their outer surfaces. This, in the *C. Ponsortii*, possesses plications which give it a slightly spinose aspect. After examining many examples of the *C. antiquior*, I have observed in some of them a tendency to become more rugose, and to pass gradually into the form represented by the above shell, and I am therefore disposed to consider it only a variety of *C. antiquior*.

DISCINA. Lamarck.

Discina Dundriensis. Moore. Pl. ii., fig. 15.

Shell small, thick, broader than long, flattened, apex smooth, elevated; exterior showing narrow bands of concentric lines of growth, which are slightly plicated, giving to the shell a wrinkled surface.

It is from the Inferior Oolite of Dundry, and is the only species known in that formation. It appears to be rare; for after a lengthened examination of these beds, I have only succeeded in obtaining three specimens.

Discina orbicularis. Moore. Pl. ii., figs. 16—18.

Shell small, orbicular, tapering to an elevated apex, giving the shell a somewhat conical form; margin smooth and rounded. Outer surface of valve smooth, with numerous concentric lines of growth; the inner smooth and very concave.

Obs.—This shell does not appear to have attained a larger size than is indicated in pl. ii., fig. 18. It is from the fish-bed and the clays associated therewith in the Upper Lias of Ilminster. By its form it is readily distinguished from any other species.

Discina Townshendii. Forbes.

A very fine specimen of this shell, belonging to the Museum of Economic Geology, was figured by Mr. Davidson in the volume of the Palæontographical Society for 1850. Its locality was then uncertain, though Mr. Davidson was informed it was from the Oxford Clay. Subsequently it was suspected to be from one of the lower beds of the Lias. Having discovered the species in the "Avicula contorta zone" at the base of the Lias, near Taunton, I am enabled to settle its position. M. Edward Suess, of Vienna, has informed me that he has also obtained the shell in the Rhætie beds of Austria, in which the "Avicula contorta zone" is included.

Discina Humphreysiana. Sowerby.

This species has hitherto been found only in the Kimmeridge Clay. It may be desirable to record its presence in the Coral Rag of Lyneham, where it is abundant.

Rhynchonella spinosa. Schlotheim.

In the Cotteswold and other lower oolites this shell has been supposed to indicate a particular zone. Although it is therein especially abundant, it is by no means confined to it. I have obtained the species from the Fuller's Earth, near Bath, and also in the Bradford Clay. Some very dwarfed or young forms of it are to be found in the upper beds of the Inferior Oolite of Dundry.

Terebratula carinata. Lamarck.

This shell has hitherto been found only in the Inferior Oolite. Some specimens smaller than the type-form are to be found in the coralline bed of Hampton Cliffs, which I am unable to distinguish from this species.

(To be Continued.)

A LECTURE ON "COAL."

By J. W. Salter, F.G.S.

(Continued from page 68.)

We finished last month with the fact that plant-remains were found in plenty both above and below the coal. I shall draw your attention first to the roof-shale—or clay over the coal—"over-clay" as it is often called: for in this the great majority of remains are preserved.

In the roof-shale two kinds of plants are the most conspicuous—fern-leaves, and the diapered cylinders mentioned in our last. These are the prevailing fossils, though there are a great many besides.

Looking first at the fern-leaves, which from their beautiful forms cannot fail to strike the observer's eye, one is surprised to notice the extremely perfect state in which they occur. Delicate fronds, spread out as for the sheets of an herbarium, with hardly a leaflet disturbed from its true place, crowd the roof-shales of nearly all coal-mines. Dr. Buckland sang the praises of this beautiful tracery, which covers the roof of the mine, in glowing strains such as it will not do for a plain geologist to imitate. I have a lurking suspicion, however, that the great doctor conceived the passage not *in* the mine, but *out* of it.

Fig. 6.—Portion of a frond of *Alethopteris* (*Pecopteris*) *lonchitica*.—Brong.

At least one hundred and twenty species are known in our British coal-strata. So perfect are they occasionally, that the little fruit-patches (*sori*, as botanists term them), are found upon the backs of the fronds. This is not very common, except in one kind—the *Pecopteris*, which happens to be more abundant than most of the others, and in some species of this the fruit is found. There is a specimen in the Museum of Practical Geology which shows these little seed-patches. It is from the Forest of Dean; and Mr. G. Roberts has shown me several, and given me some from the coal-field of Bewdley Forest. We shall give a figure of this fruit in our next number.

Some ferns, nay, many of them remind us closely of the tree-ferns familiar in our hot-houses; others resemble the humble

* Those who really wish to know more about coal-plants than this little sketch will give them, should read the article on coal in the new edition of Mantell's "Wonders of Geology." By T. Rupert Jones, Esq., of the Geol. Society.

fern-fronds of our lanes and hedge rows. But all are perfect. It is rare to find a disturbed or crumpled leaf, though of course they are often only fragments, such as our brooks and rivers float down.

I am writing for the younger readers still, or otherwise this sort of lecture would have no business in a scientific periodical, and I shall not, therefore, burden your memories with a number of Latin terms, which would be very intelligible to students, such as I hope you may all one day be. However, coal-ferns have not received christian or surnames such as our wild ferns rejoice in. Lady fern and Rock-brakes, Black Maiden-hair and Moonwort, are a great deal easier to remember than *Neuropteris Scheuchzerii*, and *Alethopteris lonchitidis*. *Pecopteris plumosa* is not such a hard sounding word; *Pecopteris Miltonii* and *P. muricata* are both tolerable. But it so happens that some of our common coal-favourites, like favourite children, have very long and unprounounceable names. Yet we do not like either the less for that.

All those I have mentioned above are well-known fossils: all of them are found on the continent as well as in England; and one or two of them are to be picked up at every coal-pit. The pretty *Alethopteris lonchitica* may be obtained in the nodules of ironstone in Shropshire, and large slabs of it come from Durham. It is sometimes known under another name, *Pecopteris lonchitica*, but the above is the true one.

Fig. 7.—*Alethopteris (or Pecopteris) Serlii.* Brongniart.—Reduced size.

We have represented only a single "pinna" of the plant, for in its perfect state it looks a good deal like our common heath-fern, *Pteris aquilina*. The *P. plumosa* is like the Lady-fern. *P. loreopteridis*, a strong-leaved fern, with a thick stalk or rhachis, a good deal resembles the *Lastrea*, and so on.

There is a beautiful fern common near Bristol, the *Alethopteris Serlii*, which has fine large leaflets like the *Polypody* except that it is a compound leaf (vipinnate) instead of a simple one. There are larger ferns still—the species of *Neuropteris* as they are called, which rival in size our tropic species. But these, numerous as they are, and common too, for there are as many of them as of the genus above quoted, are not quite so often met with. They too, though very rarely, show the fruit on the under side of the leaflets.

There are the delicate *Sphenopteris*, whose leaves are of all shapes and sizes, agreeing in nothing so much as the particularly slender and narrow shape of the leaflets and branches. They look like parsley leaves, coriander leaves, mimosa, and some again look like what they are—finely divided ferns. Figure 7* shows the peculiarly graceful character of the tribe. There are several other kinds of "*opteris*", with which, as the Scotch song says, "I'm laith to vex ye." But I must mention one that is not very common in the coal, but which has been found in a perfect state in some beds older than the coal, both in Ireland and in Scotland. This is the *Adiantites Hibernicus*, a fern first brought to notice by that eminent man and ardent naturalist, Edward Forbes. It is common in some rich fossil beds in the upper part of the Old Red Sandstone of Ireland. It puts one in mind of the fern which is the glory of Killarney—the King or Royal-fern, *Osmunda regalis*—about the same size, and with the spreading broad leaflets set on a broad stem. But whereas our Killarney friend carries her fruit on her head, that is to say, the terminal leaves and pinnæ are changed into fruit-bearing spikes, the fern that grew in old old times on the margin of the Palæozoic bogs has its lower or bottom pinnæ crowded with seeds.

(To be continued.)

ON THE DISTRIBUTION OF CEPHALASPIS AND PTERASPIS IN ENGLAND.

By George E. Roberts.

I hope our scientific tourists of the approaching season will take their good eyes into Herefordshire quarries. For now that the Scotch monopoly of the Old Red fishes is broken up, they will be found to repay time and trouble, if searched for in that and the adjoining counties; and something like a reasonable history of these strange old littoral fishes may be the result of a single season's work. There is a great deal about them well worth knowing, and their remains will be found tolerably abundant, though very fragmentary, both in the sandstones and cornstones; and therefore I have a peculiar pleasure in introducing our primæval fish-fauna to the notice of those on search already—or hoping to be as the season advances—for relics of ancient life.

Before I call particular attention to some fruitful localities, let me say a few words upon the physical condition and geographical aspect of the age they lived in. Though I ought rather to say ages, for they anticipated the advent of the system they are popularly said to belong to—that vast life-era—the extent of whose inland-seas and shallow littoral ocean-zone we see in the sandy, shaly, and gravelly beds which contain *our fishes*, and of whose deep seas the thick-bedded

* The figures of *Sphenopteris Schlotheimii*, *Adiantites Hibernicus*, and *Osmunda regalis* will be given in the next number.

limestones of Devon are witnesses—called by us Old Red or Devonian; and first appeared upon the stage in *true* Upper Silurian times; for the *Pteraspis Ludensis* of the Lower Ludlow shales of Leintwardine (county Salop), is the oldest representative of the family. Its discovery in these older rocks, though of great interest, did not in the least surprise me; for a sea-deposit, so clearly marked out as littoral by its starfishes and its shrimp-like crustacea, would be the natural home of shore-fishes, which Cephalaspides undoubtedly were. Moreover, the shells and fuci which the Lower Ludlow rock has everywhere in keeping, tell a certain tale of its shallow-water condition; and enable us by studying them to read with greater ease and increased interest, the record written by succeeding seas.

Indeed, if we are to understand the physical aspect of the Old Red age, we must make ourselves well acquainted with the foregoing Silurian; for no aid will be of greater value to us, or more beautiful as a study, than the slow and gradual transition from the deep-sea condition which prevailed over the border-counties I am calling attention to, during the accumulation of the marine limestone of the Wenlock series, and the inland lakes of brackish water, terminated, probably, by wholly freshwater conditions, which have left us the fine silty shales of the Upper Old Red as their legacies.

And thus it comes to pass, that not only for the first stages of its new physical career, but also for the birth-place of its life-forms, the Upper Silurian age is insolubly linked with the Old Red Sandstone; and in every exposure of these older rocks, which contain littoral crabs and star-fishes, we may reasonably expect to find the ancestry of the ancient shore-fishes I am describing. But though they thus anticipate the age they are popularly said to belong to, they did not—so far as we know—live beyond the close of the Old Red system; and beyond doubt their metropolis is in the grey and red cornstones of Herefordshire and Worcestershire.

The position of these beds (*see section, page* 104), which are seen in many places in these border counties to pass through a tilestone series into the underlying Silurian, is now clearly made out, and only their fossil history waits our reading. And this must be learnt by us before the true contemporaneous relations of the two very distinct rock-series which we together know as the Devonian system can be cleared up; before we can see what communication, if any, existed between the shallow waters which laid sandy sediment in Herefordshire, and the deeper ocean, which has left us hard coral-rock and shells, in Devon. Upon the physical boundaries of these waters, Eichwald has some instructive remarks in a short memoir prefacing the fish-fauna of his "Lethœa Rossica," in which he points out the marked difference between fishes of the shore and fishes of the open sea, and describes some new forms of osseous fishes from the Devonian rocks of Russia, not unlike our English Cephalaspids. And now I will mention the results of my own hunting among the Old Red quarries, and I hope, by thus putting others upon the trail, many good fishes may be taken. For more specimens are wanted before even their (precise) position

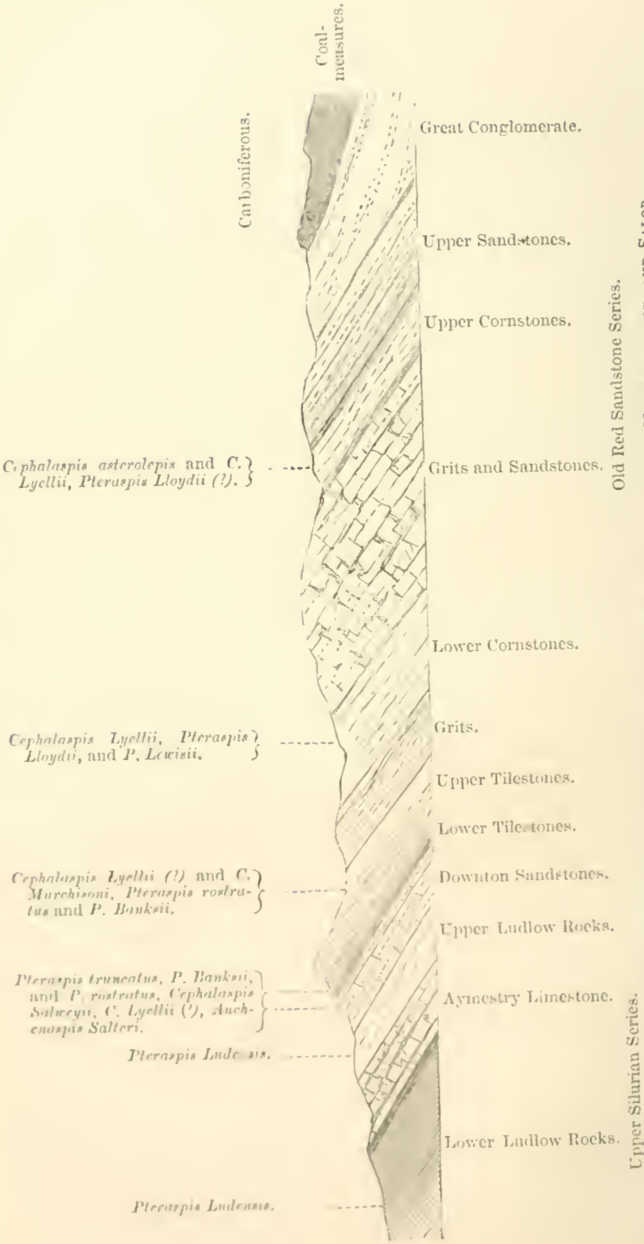
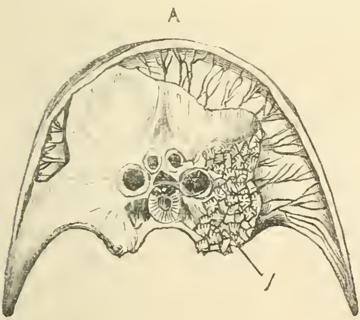
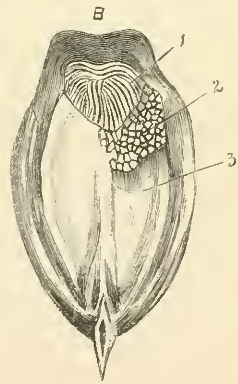


Diagram-section of the Range of Cephalaspides in Worcestershire, Herefordshire, and Salop.

among fish-families can be decided. Probably a kinship existed between the two chief forms of ichthyic test of Cephalaspis and Pteraspis, and it is most likely that our noble friend, the sturgeon (*Acipenser*), will have to own them of his family; for, as Prof. Huxley has lately pointed out, they bear, in shape and arrangement of head-plates, a great affinity to the genus *Spatularia*, a North American attaché of our larger and caviare-giving fish.

It may help the comprehension of those who are unfamiliar with the osseous head-shields of these old ganoid fishes, if I sketch the two forms whose acquaintance will be most easily made by exploring collectors, Cephalaspis and Pteraspis. Form of shell is a very deceptive guide both in fish and crustacean life; indeed, if we made our affinities from this alone, one great genus would include many species of both orders, for the shape of Cephalaspidean bucklers is copied almost literally by several crustacea. A new *Harpes* from the Silurian limestones of Oesel, figured by Eichwald, agrees not only in shape of head, but even a position of the eyes with Cephalaspis; while it would be a matter of serious concern where to draw the line between the head-plates of Eurypteris and Cephalaspis. But it is from the closest and most minute examination that species and even families are determined among those which lived during the infancy of vertebrated life.





A, Cephalaspis Head-shield.
1, Ornamented external layer.

B, Pteraspis Head-shield (as usually found*).
1, External ridged layer.
2, Intermediate cancellated layer.
3, Internal shell layer.

* A restoration of this is promised us by Prof. Huxley.

Pteraspis Ludensis, the oldest fish with which we are at present acquainted, was found in the Lower Ludlow mudstones at Churchill Quarry, near Leintwardine, and has been well described and figured, side by side with its ally, *Pteraspis truncatus*, from the Upper Ludlow rocks, by Mr. Salter, in the "Annals of Nat. Hist." for July, 1859.

P. Ludensis ranges up into the Upper Ludlow shales, in which it was found as far back as 1852 by Dr. Harley, of King's College. I have not heard of other Cephalaspids being found in Upper Ludlow rock, but in the Downton sandstone they reappear, and are abundant in the neutral ground lying between that rock and the tilestones, and still keep the company of Euryptera and Pterygoti. The Downton sandstone is well displayed near Kington; where in a quarry near Bradnor Hill, two forms of Pteraspis were discovered by Mr. Richard Banks. These are described and figured by him in the Geol. Soc. Journ., vol. xii., p. 93.

The noted railway-section near the Ludlow station is in the zone of these passage-shales, and has been most indefatigably worked by Messrs. Lightbody and Marston. Other exposures of these fish-bearing shales occur, though all are not equally prolific. The earliest true Cephalaspis comes to us from the lowest layer of the passage-bed. *Auchenaspis*, an allied genus was first found in the Ludlow exposure of the shales, but lately our best specimens have come from a south-east extension of the bed, cut through by the railway near Ledbury. An interesting memoir of this exposure will be found in the Geol. Soc. Journ., vol. xvi., pp. 193–7. Its author, the Rev. W. S. Symonds, proves the existing relationship between the Ludlow and Ledbury deposits; and notes the discovery of Pteraspis in red and mottled marls and sandstones (passage-rocks), lying above Downton sandstones at the tunnel-mouth; and of abundance of Auchenaspis (which may be described as a small Cephalaspis with a neck-collar, or plate filling up the space behind the eyes, and between the cornuted prolongations of the shield), in the top layers of the transition beds, answering in stratigraphical position to those on the Ludlow railway. The upper tilestones are the next repositories of Cephalaspids with which I am acquainted.

Many good specimens of Pteraspides came out of this rock when it was quarried at Trimpley, near Kidderminster, and two heads of *Cephalaspis Murchisoni* (?) were met with by me; but when I saw the locality last, some very fine potato-plants were making good use of their time just over the hole which had given me good fossils, and two cottages near-hand owned the quarry as a garden; so no more Pteraspides at Trimpley. But one notable exposure is left to us at Whitbatch, three miles north-east of Ludlow—a classical spot as having given the late Dr. Lloyd the first Pteraspis buckler, which still retains its name of *P. Lloydii*. The relationship between these tilestones and the overlying hard cornstone rock, pure enough in this neighbourhood to be burnt for lime, is plainly to be seen in the quarries in the Downton drive, and a more instructive walk cannot be taken than that leading through the Whitbatch woods to Hayton, Sutton, and Bouldon. Indeed, it is to this ground that I wish to direct the special attention of travelling geologists, for I cannot think it has had full justice done to its merits. Pteraspis is not uncommon in fragments among the tilestones in the great quarry on the west side of the drive to the Hall—by the way, there is a band of cornstone interstratified, which must not be confounded with the true Old Red cornstone which is quarried and tunnelled into beyond this quarry—and I have lately met with some bits of fish-armour, with cunningly convoluted striæ, fragments of a related though, as yet, undescribed genus. These also occur in a brown-red coarse grit, at the Wall Hills, near Ledbury, though higher in stratigraphical position.

I have said that through the Whitbatch portal we enter a very fine field of research, but our route must be advisedly taken; and I do not recommend another halt in our march until we have left Downton Hall and its woods behind us, and are looking down from the high grounds of Hayton, upon the beautiful dale of the Corve. If we trace northward from Upper Hayton the lines of cornstone in outcrop parallel to the course of the Dale, we shall come to some notable exposures.

At some points, Hayton's Bent, for example, they are cupriferous, though the poorness of the ore obtained, (a carbonate), has yielded but little copper, and failure has attended the works. And at another spot, near the farm-buildings of Downton Hall, they have yielded an ore of lead, in the well-known form of cubic galena.

But it is for fishes we are searching, not metals. There is a small quarry in a field at the top of Hayton, which one would think a terrible place from its being called the "Devil's mouth," but there is nothing alarming about its appearance, nor has it any strange connections that I could see, save its treasures of Cephalaspid fish. I think I never saw *Pteraspis Lloydii* of equal size to those I have taken in this quarry, though I could meet with no other species. The stone is here a fine-grained light-coloured sand-rock, interstratified with true cornstone. Two miles east of this place, in the Upper Cornstones of Hopton Cangeford, the monarch of the Cephalaspides in point of size, the great *C. asterolepis*, was found by Dr. Harley. More of this noble fellow when we mount up to him in time, and ascending order of beds.

On the same horizon, and yielding more or less evidence of their former life are the cornstones of Hall's Barn, near Kidderminster, and of Cradley, near Malvern. In both places I have found fragments of Cephalaspis and Pteraspis in abundance; but I need hardly remind the collecting geologist that good scutes are of very unfrequent occurrence; the majority of specimens having been laid with the breccia-like gravel, whose weight and unequal pressure were enough, even if motionless and undisturbed by currents, to have broken up the shell-like plates. And in fact such an amount of grinding did actually take place among the shallows and pebble-reaches of the Old Red lagoons, that more than one layer of coarse grit lying above the lower cornstone is seen by a lens to be crowded with blue and purple atoms of fish-shell, the triturated remains of many a good Pteraspis.

Steering north, with a slight easterly inclination, from the Hayton quarry, we shall find several breakages into the lower cornstones, near the apex of the ridge, at Sutton and Bouldon and Tugford. Pteraspidean plates are to be found at each of these places, and a halt may be advantageously made at every quarry. The Sutton quarry is well worth staying at, for here the head-plates of Pteraspis are of frequent occurrence, and are much better preserved than elsewhere, phosphate of iron having coloured them blue and purple, and chemically fixed the outer striated layer of shell—so seldom found in position—to the internal cancellated and filmy ones. At Bouldon too, in the quarry near the mill, Pteraspis is not unfrequent; but the cornstone is coarser, made up of larger and more angular pebbles, and the fossils have suffered many breakages from being laid in their company. On the opposite side of the dale, good Pteraspides have, I believe, been found at Norton, a small village nearly opposite to Hayton; and if we turn eastward from that point, and skirt the foot of the Titterstone Hill, we shall get some specimens of much interest from a quarry near Farlow. Indeed, the finest specimen of *P. rostratus* I ever saw, came from a sandstone rock occurring with cornstones, near the forge in that village.

There is another good exposure of fish-bearing Old Red which has had scant justice done to it—the beautiful country lying north of Bromyard. At Hinston and Acton Beauchamp, near this town, *Cephalaspis Salweyi* has been met with. This is a large species, having its enamel layer covered with "pearly drop-like tubercles" of small size, which, together with its other distinct characteristics of shape and ornamentation are described by Mr. Harley, in the Quart. Journ. Geol. Soc., vol. xv., p. 504.

I think it likely that the Upper Cornstones occur near Tedstone Delamere, though I have been unable to verify this by a visit. This hard brecciated band is well worth searching for, as it contains in the two openings made into it, of which I am aware, that very beautiful species, *Cephalaspis asterolepis*—the monarch, by virtue of size and ornamentation, of the "Buckler-heads." A short memoir is given by Mr. Harley, in the Quart. Journ. Geol. Soc., vol. xv., p. 503, which, as we learn from a note appended, will be incorporated with the description of Cephalaspides to be published by the Geological Survey. The outer surface of the head-shield possessed by this regal fish is ornamented by tubercles, variable in size, but larger than those of *C. Salweyi*. But the most wonderful structure is that of the inner plate—borrowing the words of Mr. Harley—"It presents lacunæ and long branching canaliculi precisely resembling those of human bone. Many of these are completely injected with a transparent blood-red material; and so beautifully are they thus displayed, that one ignorant of the structure of bone would be able to apprehend it by a glance at a minute part of this ancient fragment. So wonderfully indeed has nature treasured up her secrets in this disentombed relic of a time so distant as to be incalculable, that she distinctly reveals in their minutest details the structure of canals not more than the one fifty-thousandth of an inch in diameter, and such as defy the skill of the anatomist to inject." Several good specimens of *C. asterolepis* have been from time to time obtained by me from an exposure of the Upper Cornstones at Heightington, near Bewdley. But the mine is now exhausted; for my good friend, Mr. Baugh, of Bewdley, who has followed up my researches in Worcestershire by constant and unwearied attention, assures me that no other specimens can be got from the stone brought up from the now filled-up quarry. Less is known about the tuberculated Cephalaspides than of those whose head-shield is ornamented by scale-like area, marked out by the out-cropping of minute vascular canals, entering the disk from beneath, and exhausting themselves upon its surface. This true reading of the external appearance of *C. Lyellii* is contained in a paper by Prof. Huxley, in the Quart. Journ. Geol. Soc., vol. xiv., p. 270. Equally careful and minute is the description there given of the layers which unite to form the cephalic shield of Pteraspis. Briefly their characters may be thus given—the innermost layer is a thin delicate lamina of enamel, somewhat nacreous, and occasionally tinged with colour; the middle layer is composed of vertical plates of like substance, so arranged as to enclose polygonal cells, whose summits or external apertures are closed by an excessively delicate filmy layer, minutely reticulated; and lastly the outer plate consists of a hard layer, strongly ridged, whose summits are turned outwards. In one species I have observed the external edges of these ridges to be minutely toothed. Most of the characters of this triple armour are shown in the annexed sketch of Pteraspis.

Thus I have briefly called attention to the occurrence of these fishes in several places, though their condition is usually fragmentary, in the Old Red of England.

And so, we bid our adieus to these shield-bearing ancients; but only that we may meet them elsewhere, and obtain from them in the field their willing tribute to our scientific treasury. Much has been written about them, but more remains to be said. And while the story yet to be told is in the careful keeping of an accurate naturalist, any collector who can find and contribute a readable fragment may be proud of being associated, not only with a memoir of the earliest known fish, but also with that which dignifies the study of Cephalaspis and Pteraspis—the history of the first appearance of vertebrated life.

NOTES AND QUERIES.

Tertiary Strata in Kent.—Dear Sir,—It has been aptly said by one of your correspondents that deep railway-cuttings, though presenting difficulties to the engineer, are great helps to the geologist; and the sections exposed in the new London, Chatham, and Dover Railway, are particularly interesting in showing the geological features of East Kent. As one who has taken deep interest in the geology of the county, and has studied these cuttings, particularly that over the chalk near Canterbury, at Beakesbourn, perhaps I may be permitted to give a short account of them, through the medium of your valuable journal.

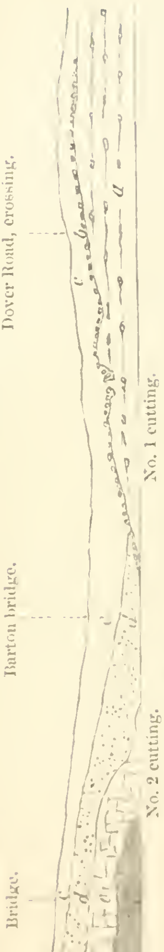


Fig. 1. Geological Sections on the London, Chatham, and Dover Railway, between Canterbury and Beaksbourne.

To those readers who may not have studied the geology of Kent, I may state that our principal knowledge of the Lower Tertiary formations there are derived from those excellent papers on the Thanet sands, and the Woolwich series by Mr. Prestwich, in the Geological Society's Journal; and it will be remembered that these sands are the British representatives of the Lowest Tertiary or Lower Eocene deposits. These series are abundantly exhibited, overlying the chalk in the railway-cuttings between Woolwich and Canterbury. The lowest more particularly in the cuttings between Canterbury and Beakesbourne, which I will now describe.

The London, Chatham, and Dover Railway, after crossing the valley of the Stour, passes to the south-east of Canterbury, and the first cuttings are through chalk. It crosses the Dover road at about a quarter of a mile south-east of the town; the depth of the cutting in the chalk being about twenty feet—that is to say, there is a depth of about fifteen feet of chalk, and over it a depth of five feet of brick-earth (post-Pliocene). Between the chalk and the brick-earth is a stratum of irregular flints, about six inches in depth, as shown in the accompanying diagram.

In No. 1, *a* represents the chalk; *b* the flint stratum; and *c* the drift. In No. 2 cutting, *c* represents the drift, and *d* a stratum of sand of ochreous colour, having a thin stratum of ironstone, supposed by me to represent the Woolwich sands. In No 3 cutting, *c* represents the drift; *d* the Woolwich sands; *e* the glauconite; *f* the grey plastic marl. These two last represent the Thanet sands of Prestwich; but seem to differ in their lithological character from those described by him. There is nothing particularly worthy of note in *c* and *d*; but stratum *e* is composed of an indurate greenish sandstone, in its upper portions approaching in colour to the ochreous sand at *d*, having chertstone interspersed. This sandstone is very hard in places; but not in large blocks. It appears split into perpendicular and transverse sections, and abounds in

Fig. 2.—Beaksbourne Cutting.—*f*, Gravel; *g*, Sand; *h*, Peat.

shells; the characteristic one of which is *Pholadomya cuneata*. *This sandstone does not effervesce with acids, except in portions which show evident traces of shells. Beneath this at *f* we have grey or blue marl, the upper portion immediately under the sandstone being mostly composed of a green sand abounding in shells much like *Cyprina Morrisii*. This rock passes into a tenaceous grey plastic clay, very hard, and possessing a complete conchoidal fracture. This grey marl is very distinct in colour and appearance from the green sandstone above; it abounds in lignite and iron pyrites. The depth of the Beakesbourne cutting is about thirty-five feet. The average depth of stratum *f* is about eighteen feet, of *e* about ten feet.

The fossils found in the green sandstone, *e*, consist of *Pholadomya cuneata*, *Pholadomya Koninckii*, *Cucullea decussata*, or *C. crussatina*; small *Corbula* (?), *Cytherea*, *Cyprina*, *Turritella*, *Natica*, *Glycimeris* and *Panopæa* in casts; fossil fruits; several casts of *Pholadomya*, differing from most already described; some *Echinanthus*, or Echinoderm.

In the grey marl, *F*, were found *Pholadomya margaritacea* (?), *Rostellaria*, *Cyprina Morrisii*, *Natica*, *Pinna*, *Tellina*; also a supposed *Venericardia*. Several curiously cylindrical bodies resembling Calamites, lobsters' claws, &c.*

From the organic remains found in these cuttings we should have no difficulty in referring them to the Thanet sands of Prestwich, but they seem to differ in lithological character, and approach very closely to those sections described by Sir Charles Lyell, as occurring at Tournay, under the term of Glauconite, and grey marl, and classed in Belgium as the Lower Landinian. It has been surmised that these formations in Belgium were represented in Britain by the Thanet sands; and these sections I have described would seem to warrant the conclusion. I have attentively read Mr. Prestwich's paper on the Thanet sands; but do not find that he has described any portion which exactly corresponds with these sections. He speaks of the Thanet sands as to their lithologic character, and describes them as "consisting essentially of a base of a light-coloured quartose sand, mixed in its lower beds more especially with more or less argillaceous matter, but *never passing into distinct clay*." The argillaceous matter is usually light-coloured, and does not therefore colour the sands, merely giving a certain amount of cohesion, so that when dug the beds are sometimes semi-indurated. In some places moreover, the clay with which the sands are mixed is dark coloured, as in the lower beds at Pegwell and Herne Bay."

The sands described as dark coloured by Mr. Prestwich, are for the most part not accessible, being below low-water, or obscured by recent deposits; and it must be remembered that the sands at Reculver are represented as being seventy feet down to the chalk, though only twenty-five feet of them are exposed. It would thus be seen that Mr. Prestwich's description would only refer to the upper part, and this the least considerable. However this may be, I believe that there is much yet to be learnt of this important geological formation, and these cuttings I have been describing may reward the search of the diligent geologist. Before concluding, I may add that I have had the opportunity of observing the lower beds of the Thanet sands, having sunk a well at Stourmouth, passing through the Thanet sands down to the chalk, which I reached at a depth of one hundred and forty feet from the surface, and a depth of one hundred feet from the lowest bed of sand; so that this dark coloured blue clay, which I term the basement bed of the Thanet sand is of considerable

* It is not to be supposed that this is anything like a complete list of the fossils found in these cuttings, but most of those I have had an opportunity of examining; and the difficulty attending the correct determination of species from casts and shells in which the hinge is not exposed, renders the correct naming of these specimens, by so inexperienced geologist as I am, a matter of great difficulty. I, therefore, with great diffidence give the names as an approximation of the truth.—G. D.

thickness, and would more deserve the name of plastic clay. I have reason to believe, moreover, that this deposit is not always present; as I have observed, only a slight trace of it in a section that is exposed, of the Thanet sands at Wingham, where the section exhibited reaches to the chalk.—GEORGE DOWKER, Stourmouth House, Wingham, Kent.

ADHEMAR'S THEORY.—In "The Geologist" for January, there appears in the "Notes and Queries," "An 'Early English' View of Adhemar's Theory." Allow me to call your attention to a work, of which I copy below the title page.

"An Essay on the Physico-Astronomical causes of Changes on the Earth's Surface," by Sir Richard Phillips. With preface by Willm. Devonshire Saull, F.G.S., &c. Published by Sherwood, Gilbert, and Piper, 1832. A note shows it was "First published in the Monthly Magazine, in 1812, and re-printed with other essays in 1821." The first publication, in 1812, was evidently the Magazine "article" from which your correspondent quotes.—C. K.

BONES OF THE DODO.—At a meeting of the Zoological Society, Dec. 11th, Mr. A. Newton noticed the discovery of some bones of the dodo in the Mauritius.

GEOLOGICAL EXCURSIONS TO THE CHANNEL ISLANDS.—As comparatively little is known of the geology of these extremely interesting islands, a few words on the subject, perhaps, may not be unacceptable to the readers of "THE GEOLOGIST." The tourist, embarking either at Southampton or Weymouth, will, on arriving at any one of the Channel Isles, be struck at once with the difference in the geological character of the rocks around him to that of those he has but the day before left behind him; and on closer examination he will perceive, instead of the low Tertiary cliffs of the Isle of Wight and its vicinity, or the oolitic crags of Portland, that he is surrounded by mica-schist, granite, and syenite, or other primary non-fossiliferous rocks. No true organic remains there are within his reach, and during his stay in these islands he must content himself with specimens of rocks and minerals. It is my intention therefore to bring before my readers, in a few geological excursions, the principal features of interest in these islands, hitherto almost unexplored by the geologist.

To begin with Jersey—the largest and most important of the group. After passing by the low sandy shore — where, by the bye an important and comparatively recent geological change has taken place, which will be hereafter spoken of— and the tall granitic cliffs on the south-western side, which have been here and there excavated into caverns by the action of the sea, the traveller will arrive at the chief town, namely, St. Helier's, and on landing will see on his right hand a fortress, which is built on a lofty rock of syenite. The pier on which he will land is made of a beautiful pink or reddish-coloured granite, which is extensively quarried on the opposite side of the island, at a place called Mont Mado, where great crystals are occasionally found in the granite quarries; but these are of rare occurrence. The granite here worked varies in colour in the different quarries; some is of the reddish variety above-mentioned, some is grey, and some of a yellowish tint.* The first place worthy of notice to which I would introduce my readers is the north-western point of the low flat sandy bay before mentioned, where it was stated an important geological change appears to have taken place. Tradition asserts that in this bay of St. Ouen's there formerly was a large forest extending far out where the sea now is, and which ages ago was buried beneath its waves. But let us inquire into this statement: in the the first place, there are landowners who even to this day pay rent for land which their ancestors formerly possessed in this forest. At low water, during spring tides, if search be made, stumps of oak trees can be found firmly imbedded in the sand; these show, at any rate, that although

* Due, I believe, to oxide of iron. There is only one narrow vein of this kind found in this island.

the extent of the forest may have been greatly exaggerated in these traditions, yet that in a former age there were decidedly trees growing there; and that the sea has encroached, as I believe it still continues to do, on the land. I have no doubt that if search was made peat would be discovered under the sand, as is the case in a similar locality at Vason Bay, Guernsey, which I will speak of hereafter, where filbert-nuts and vegetable remains are found, just as in the peat-deposits in Ireland and other places.

From this spot the rugged cliffs of the northern shore commence extending onward for about twelve miles: they are granitic; but veins of syenite, quartz, felspar, and porphyry everywhere intersect the granite. On this coast there are numerous quarries of the granite already mentioned at Mont Mado; also some porphyry quarries at a place called Fremont. The stone here looks almost as white as chalk; but on being broken it is often curiously stained with oxide of iron. If after passing these quarries the road is taken to the left, it will lead over the cliffs to Bowlay Bay, which is a very interesting locality to the geologist.

Here commences the curious conglomerate, or pudding-stone, which extends along the eastern coast. It consists of fragments of rocks cemented together with an argillaceous paste containing oxide of iron. In this vein it occurs of a beautiful green colour. Here, too, numerous pieces of a compact green felspar are to be found strewed over the beach in various directions. The conglomerate extends along the shore as far as St. Catharine's Bay, where it abruptly ceases, and joins the porphyritic rocks which form the coastline as far as Groutville Bay, where the schistose rocks, forming the southern portion of the island, commence. On the road near Gorey one of those singular Druidical cromlechs will be seen, of which there are several in the island. In these, human bones, and even entire skeletons, amulets, flint-implements, celts, cleavers, ashes, and pieces of pottery, have from time to time been discovered.

Beds of amygdaloid are found in the island, which is much used for building-purposes. In many of the syenite quarries, on the surface of the stone, slight traces of binoxide of manganese have been found.

Green porphyry is also quarried in some parts of the island. The following is a list of the principal minerals which have been found in the various parts of the island of Jersey. Iron-pyrites; oxide of iron; binoxide of manganese; copper-pyrites; quartz; epidote; carbonate of lead; felspar; hornblende; titanium,

The geology of the island of Guernsey is more varied, and consequently more interesting than that of Jersey; but I can only briefly notice a few of the most striking points in it. The southern part of the island rises to the greatest height, and consists chiefly of gneiss and other similar rocks; the western side is principally syenitic. Granite makes its appearance at the northern extremity; then hornblende (both schistose and amorphous) follows on the eastern side; syenite appearing here and there. The town of St. Peter-Pont is situated in a valley, between the junction of the syenite and gneiss. There serpentine is found; also talcose schist. A blue grey variety of granite is extensively quarried and much used for building-purposes; and veins of that curious mineral, "graphic granite," are found in the island. The rocky scenery of the southern cliffs is extremely grand and magnificent; and there are some curiously shaped rocks at a place called Moulin Huet. These appear to be of a schistose character; and on account of the decomposition of the rock by the influence of sea and air, numerous minute cones have been formed, and the disturbed portions of stone lying about in every direction give a very picturesque appearance to the scene. In the parish of Torteval trap is found, veining the gneissic rocks, and presenting the usual terrace-like appearance. Small and narrow veins of crystalline carbonate of lime are found in the gneiss, but these are very scarce. The following minerals have been found in this district by a local geologist. Sulphate of iron, mundic, specular iron-ore, sulphuret and the black and green carbonates of copper, carbonate of iron, iron-ore, brown and pearl spar, sulphuret of lead, carbonate of lead, sulphuret of manganese, epidote, schorlite, actinolite, prehonite, steatite, asbestus, talc, and pot-stone.

On the western side of the island there is a bay where an extensive peat-bed was discovered not many years since. It happened thus: after a heavy gale, masses of wood and peat were seen floating about, and several pieces were stranded by the force of the waves on the shore; the sand and shingle which form the sea-bottom having been removed by the fury of the storm, these beds of peat, which lie exactly below them, were thus exposed and portions uplifted, which to the astonishment of the islanders were strewed over their shores. "Trunks of full-sized trees, accompanied by the wreck of humbler plants, which once carpetted the meadows where they grew, roots and rushes, surrounded by moss, gave evidence of the rank luxuriance of the locality. The compression of the trunks and boughs exhibit the first indication of that flattened form which all fossil plants undergo, by the superincumbent pressure during the slow decomposition of the vegetable fibre, without the complete destruction of the texture of the wood. The trees were overspread with corallines, fuci, and sertulariæ; and riddled with the numerous perforations of three species of *Pholas*, *P. dactylus*, *P. candida*, and *P. parva*, the dead shells of which were found in their holes. Pieces of pottery, stone-implements, teeth of horses and hogs, have likewise been discovered in the peat."* This peat is used for fuel, and is called by the natives "gorban" (corban, *i. e.*, a gift).

From the position and appearance of this peat, we may conclude that an extensive forest once extended along a great part of the western shores of Guernsey, and that the sea has gradually encroached on the land at this side of the island; and it is well known that part of Guernsey, called the "Braye du Val," was only prevented from being swallowed up by the sea by means of an embankment made near the Val church in the year 1808; for the encroachments of the sea over this tract of land became yearly more and more apparent. The shores of this part of the island are low and sandy, everywhere dotted with little hillocks of drifted sand. Druidical cromlechs are here very abundant, in which many curious relics of antiquity have been discovered. The largest cromlech is composed of five cumbent stones of immense weight, covering an area of twenty-nine feet long and twelve wide; in this were found many human teeth and bones, and some entire earthern vessels. There are several other "druidical temples" in the vicinity of l'Ancresse. On the south-western side of Guernsey there is a rocky islet called Lihon, which is accessible to the pedestrian at low water; but at high tide must be reached by means of a boat. On account of the beds of gravel, which here repose on the granite, as also from marks of a supposed ancient sea-margin on the rocks, some have imagined that the present elevation of the district is much higher than formerly; these layers of gravel have been accounted for, however, as having been washed by rivulets and rain from the high southern lands of Guernsey down to this lower part of the island; but there still remains the marks on the rocks at Lihon to be accounted for. There is a similar appearance of a raised sea-beach on the north-western coast, near a place called "Paradis."

The islet of Lihon consists chiefly of gneissic rocks, traversed in some places by veins of felspar. There are the remains of an ancient priory; and in the rocks on the shore of this island are to be seen two curious natural basins—scooped out of the rock by the violence of the sea—which tradition asserts

* Extract from a letter of Mr. Jukes to the "Guernsey Star."

were used as baths by the nuns of the convent of Lihon. A similar excavation occurs near Grêve de Lecq, in Jersey.

Situated about seven miles from Guernsey, and twelve from Jersey, lies the beautiful little island of Sark. This island is about three miles and a half in length, and one and a half in breadth. Although small, there are a great many objects of interest in it. It is divided into two parts, Great and Little Sark, connected only by a tall and narrow pass, called the Coupée. On the west side of Sark there lies another still smaller island, called Brechon, or "l'Isle des Marchands," which is divided from Sark by the Guilot stream, or channel; this island is about three-fourths of a mile in length, and half a mile broad. Granite and syenite, as usual, form the basis or lowest rock, on which a great variety of the metamorphic rocks repose, forming the body of the island. The granite makes its appearance at the two extremities of the island; then syenite follows, in which on the southern side many mineral veins exist, and at a place called Port Gorey, in Little Sark, mines of silver were for some time worked; but the amount raised was not considered sufficient to defray the expenses of the working, so they were after some time entirely abandoned. A great variety of minerals were found in these mines, amongst which were muriate, chloride, and sulphuret of silver, carbonate, sulphide, sulphuret, and phosphate of lead, carbonate and sulphuret of copper, sulphuret of antimony, and antimoniferous galena. The beautiful mineral, ruby silver, was also found, and veins and crystals of carbonate of lime. Heaps of the silver ore still remain scattered about near the mouths of the shafts, where good specimens can be obtained. At the time the mines were abandoned the amount of silver which was raised was upwards of twenty-eight thousand ounces, besides a great deal of copper and lead.

At the Coupée, before mentioned, there is a vein of porcelain-clay, about eleven feet in thickness, which appears to have proceeded from the decomposition of the granite. This is mostly white, but oxide of iron (red, purple, and yellow), and veins of quartz, intersect it in many parts. The rocks in this locality are of mica-schist, and at a place called "Le Pont du Moulin" they assume an interesting appearance, on account of their horizontal stratification, this is particularly remarkable in three masses of rocks, called the Alterns (Les Autelets), near this spot.

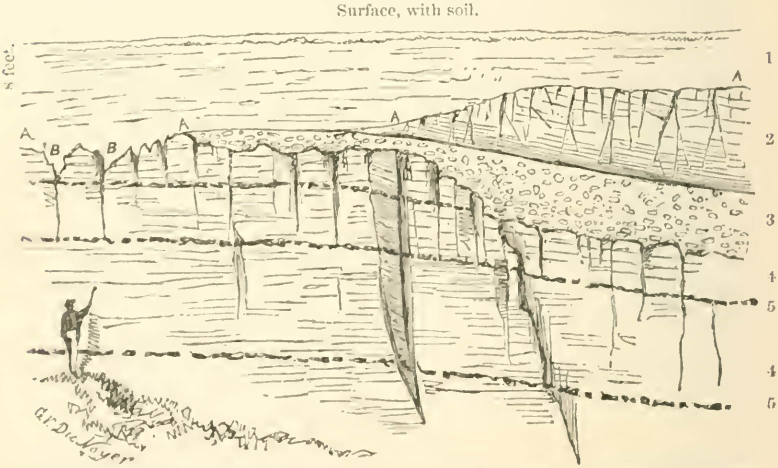
Saxa, vocant Itali, nudüs quæ in fluctibus aras.—Virgil.

These singular looking masses stand out alone, some distance from the shore, and look like piles of masonry, or some artificial structure. Probably they were the buttresses of a natural arch which has been washed away by the sea. On approaching the northern point the original granite again makes its appearance, and on the eastern side of the island veins of trap, greenstone, and quartz occur. Porphyry too is found near Le Grêve; the quartz sometimes is found of a pink colour, somewhat resembling the rose or milk quartz so abundant in Norway and Sweden. Pot-stone, or lapis ollaris, is found near Havre Gosslin, and is used by the inhabitants in making vessels for domestic use, as it can easily be cut with a knife. Talc, hornblende, actinolite, and chlorite are also found.

The island of Brechon, or l'Isle des Marchands, consists chiefly of gneiss; but veins of different rocks occur, and here a mineral lode was discovered and worked with some success; but this also was finally abandoned. Copper was the principal metal found there. Another metal lode was discovered at Le Pot. In Little Sark, in many of the caves metallic traces are discernible: iron pyrites is found in some of them.

I cannot conclude these remarks on the geology of these islands without some notice of the curious caverns found in many of the cliffs, called by the natives "creux." These are crater-shaped cavities, having generally steep rocky sides open from above, and in all cases a tunnel which communicates with the beach below. The tunnel, probably, was formerly the cave, the top or ceiling of which giving way, produced the curious tunnel-shaped appearance as seen from above. There are several of these; one near Sorel, in Jersey, called "Le creux du vis," and two in Sark, called "Le creux terrible," and "Le Pot," being among the most remarkable. There are many other ordinary shaped caves in all the islands, produced both by the action of the sea on the softer strata, and by the first great upheaval which raised these islands from the ocean.—J. H. MACALLISTER, Stoke Goldington.

DRIFT AT DONALD'S HILL, IRELAND.—DEAR SIR,—As any fact which elucidates the occurrence of osseous remains in what is called "The Drift," and the probable age or history of that deposit as determined by such collateral evidence, is at present of especial interest to geologists, the accompanying sketch and remarks, taken from one of my note books, will, I am sure, interest you.



Quarry in Chalk, or "White Limestone," at the base of the Basalt, 700 feet above the sea. South flank of Donald's Hill, townland of Kilhoyle, co. Derry: (sheet 17, Ord. map).

1, Drift clay, formed by the disintegration of the basalt.
2, Basalt, compact at top, becoming soft and earthy below, and resembling a variegated shaly sandstone.
3, Hardened chalk-mud, containing sub-angular lumps of red and grey (chalk-drift, below the basalt).
4, Upper chalk with flints, hardened to a compact limestone with conchoidal fracture.
5, Layers of flint.
A A, Base line of recent drift.
B B, Hollows in the surface of the chalk, containing fragments of deer's horns and bones.

On the southern flanks of Donald's Hill, county of Derry, town-land of Kilhoyle, and at an elevation of seven hundred feet above the sea, a large quarry was opened many years back, in the hard, or as it is called by geologists, "altered chalk," known locally as "white limestone," at the very limit of the escarpment of superincumbent basalt which covers the entire remaining upper portion of the mountain. The chalk, which, as usual in the counties of Derry and Antrim, resembles a close-grained compact white marble, with a conchoidal fracture—is here, as elsewhere, overlaid by a stratum of drifted sub-angular flint shingle, enclosed in what was once chalk mud; but which is now nearly as hard as the chalk itself. On this ancient chalk-drift the basalt rests—the junction between the two being sharply and clearly defined, (vide right hand side of the sketch).

The cutting afforded by this quarry shows that the basalt, the ancient chalk-drift, and the chalk itself, have been denuded; and a layer of dark brown clay, formed apparently exclusively of disintegrated basalt, spread over all to the depth of eight feet.

The surface of the chalk beneath its ancient flint drift, as well as the more recent basalt clay deposit, has been worn into hollows and cavities of variable width and depth; and in those filled by the basalt clay, the quarrymen frequently find the fragments of deer's horns and bones. (See left hand side of sketch at *b, b*).

With regard to the probable age of this drift basalt clay, there are some who may probably suppose that it is comparatively recent; and the product of rain and snow wearing away and washing down the basalt from the higher lands of the mountain on to its flanks. Such would be a hasty conclusion. Rain acting on disintegrating rock does not deposit its sediment, or fine detritus, on the flanks of hills; but carries them by the floating power and velocity of its waters to the lowest lands of the plains, and eventually to the bed of the ocean. If that was the origin of the deposit, its formation should be still progressing; but it is very evident that the contrary is the case.

On carefully studying the facts presented to us in this quarry, it is clear that the era of the last great denudation was drawing to a close before the formation of this basalt clay, which must have been deposited as mud at the bottom of possibly a shallow sea or estuary. It belongs therefore to the Glacial or Escar Drift, which bears the same relation to the other rocks as this clay does to those beneath it. The horns of the deer, and bones of the same animal, or of others, may have been washed into the sea, and swept by tides and currents on to this bank of silt, through which they sunk till they rested on the surface of the chalk beneath.

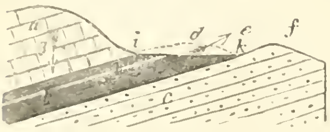
If this supposition be true, and I see no reason to question its correctness, we have evidence here to show that deer, and very possible other animals, existed in these latitudes, while the land presented a very different configuration to that which it now has; and a large portion of what is now the north of Ireland was more than seven hundred feet lower than at present, and therefore submerged beneath the level of the sea.—Truly yours, GEO. V. DU NOYER, Dublin.

DITHYROCARIAN CRUSTACEAN REMAINS AT PORTMADOC.—SIR,—Allow me to inform your readers that the "New Crustacean form allied to Dithyrocarus," referred to in your last number, page 74, occurs in this neighbourhood (Portmadoc), and has recently been collected by me from the lower Lingula beds at Wern.

My specimen is the exact size of your woodcut, which is rather larger than the Skiddaw specimens lately sent me by Mr. Gregory, of 3, King William Street, Strand, who has, I understand, some very fine examples.—I am, Sir, yours obediently, JOHN ASH, Portmadoc.

CURIOUS GEOLOGICAL FACT.—In a field, the property of Mr. Renton, situate a short distance from the point where the Leeds and Liverpool Canal is crossed by the Midland Company's railway, at Idle, near Bradford, is a considerable hill, or piece of rising ground, which has been noticed to be gradually attaining greater elevation during a period extending over the last thirty years. There are even young men who remember the field being quite level, whereas now there is a mound near the middle of it. The cause of this singular elevation has given rise to much speculation. Some persons suppose that it is owing to the upward pressure of water in the bowels of the earth.—"Times," Nov. 22, 1860. What does this mean?—QUERIST.

We do not know the hill referred to, but we should think from the above paragraph that the rise of the ground mentioned was caused by some neighbouring hill or higher land, the weight of which, pressing on soft clay beds, would cause them to rise up, probably at their outcrop. The accompanying diagram will illustrate this action. If a limestone hill *a* presses by its weight (see downward arrow *g*) on a clay stratum, *b*, resting on hard rock, *c*, the effect of the weight must be to compress or flatten the clay bed *b*. If this clay bed can find a vent, which it would naturally do at its outcrop, *i k*, the effect of the pressure would be to cause the clay land to be squeezed out there in the direction of the arrows, *h e*; the highest elevation, or crown of the dome of the raised tract (shown by the dotted lines) being at *d*. This kind of elevation is not uncommon in gault districts, which are thus pressed up between the Chalk and Lower Greensand.—Ed. Geol.



Fossils from Old Red Sandstone at Whitbatch.—Sir,—It may be interesting to some of your readers to know that I have procured a nearly perfect *Cephalaspis Lyellii*, from a quarry of the Old Red Sandstone at Whitbatch, near Ludlow. I believe this to be the most perfect Cephalaspis that has been found in this neighbourhood—I only know of one other specimen showing any portion of the body; that specimen was procured some years ago, from some men that were breakers of stone for the road near Pontrilas; but the exact locality where it came from is unknown. The quarry at Whitbatch is a very prolific one for Cephalaspides; and some very fine Pteraspides have been procured from it.—I am, Sir, yours, &c., Alfred Marston, Cove Street, Ludlow.

List of Fossils found in the Old Red Sandstone, in the neighbourhood of Ludlow, By A. Marston.

Species.	*Localities.*
Cephalaspis Lyellii	Whitbatch, Bouldon.
——— *Salweyi*	Oakley Park, &c.
——— *asterolepis*	Whitbatch.
Onchus, fish-defence	Whitbatch.
Pteraspis rostratus	Downton Hall drive.
——— *Lloydii*	Whitbatch.
——— *Crouchii*	Bouldon, near Bouldon Hall.
Spiny Stem of Tree	Whitbatch.
Fucoids, very large	Bouldon.
Egg-packets of Pterygotus	Whitbatch.
Fish-Tracks	Bouldon.

Skeleton of a nondescript Animal found near Buenos Ayres.—In a book of travels in Spain, published (anonymously) about sixty years ago, the writer, in describing his visit to the museum at Madrid, mentions that "The most remarkable and interesting object in the cabinet of natural history (which occupies a suite of ten rooms), is the skeleton of a nondescript animal which was discovered some years ago, buried about forty feet in a mountain, near Buenos Ayres. The length from its rump to its nose is about thirteen feet: its height a little more than six. The breadth and size of its body are very astonishing; and the collar- and blade-bones are not unlike those of the human species. The legs are uncommonly stout, particularly those behind, which are of such prodigious and wonderful strength that they must have been designed to support, upon occasion, the whole body of the animal reared up; an idea which is rendered more probable from the length of the claw and the solid piece of bone which projects behind, forming a basis to the leg. Whether it was a carnivorous animal or not is still, and will probably always remain, in great doubt. The enormous claws are in favour of such a conclusion; but the evidence of the mouth is against it, which is merely furnished with common grinders, without fangs, or any traces of them, though that part of the skeleton is entirely perfect. The neck is long enough to touch the ground. It is evidently of the cat kind, and appears to have been a sort of gigantic tiger. The breadth of the animal and the solidity of its bones are wonderfully striking."

Can you inform your readers whether the remarkable fossil animal above mentioned is still in the museum at Madrid; and whether it has been seen and described by anyone who (from the great advances made in geology of late years), is better qualified to give a more particular and scientific account of it than the writer of these travels?—QUÆRY.

ERRATA IN MR. PRESTWICH'S PAPER ON CLIFF SECTION AT MUNDESLEY, NORFOLK.—At page 70, 9th line, omit reference mark (*g*); 30th line, for *littoralis* read *littorea*.

REVIEW.

The Cleveland Ironstone. By J. BEWICK. London: John Weale. 1860.

In a paper which appears in our pages this month upon the geology of Cleveland, the writer has made a casual reference to the volume before us, by Mr. Bewick, which has very lately appeared from the press; but as it is intended to be an exhaustive treatise on the subject, it demands a more particular notice than we might otherwise have bestowed upon it.

The volume shows a vast amount of observation amongst the strata of the district, and gives a tediously-minute history of the development of the Lias iron-seams in the Whitby district, where their commercial value appears first to have been recognised. We may date the birth of their importance, indeed, from the year 1838, when the Wylam Iron Company leased the ironstone on the estate of the Marquis of Normanby. Mr. Bewick's observations, however, are too much confined throughout to what is usually called the "Grosmont district," which has now been outstripped in point of importance by the discoveries in the neighbourhood of Guisborough.

When the writer speaks of the fossils of the Lower Lias as "the remains of antediluvian animals which enjoyed life, in all probability, at a date far beyond our chronology," he will find few geologists to dispute the probability; but when he longs for "some Newton to teach us more than we know of the *birth of matter*," the probability of his hopes being realized is scarcely so well founded. In most pages there is work for a judiciously handled pruning-knife; whilst there are within them the elements of a scientific treatise of the greatest value. The inaccuracies which we notice in the present volume might easily be rectified, and much interesting matter added, which is now wanting. We do not certainly see any reason for "inferring" from any facts which the volume contains, "that the rocks upon which the Lias rests are of a very uneven character," although such may undoubtedly be the case. When, again, the basaltic dyke, which intersects the district, is referred to as the "probable disturbing element" by which the rocks in Commondale are said to be uplifted on their edges, a glance at the phenomena there exhibited would at once negative such a supposition: on each side of the dyke the strata retain their horizontal position, or whatever inclination they may have had previously, without any sign of violence or alteration, except such as we should expect from their having formed the walls of a dyke of molten matter. The strata are never either "twisted" or "contorted," as most would understand the terms, and certainly not, near Dibble Bridge and Westerdale, as Mr. Bewick has described. The seam at Fryup End, which we find there spoken of as the Lias seams which have been opened out and show a thickness of ten feet, is in reality the oolitic seam of the Inferior Oolite immediately below the great sandstone rock, as may be seen in the narrow defile of Crunkley. The Lias beds are, at this particular point, two hundred feet below the surface; the seam opened out is analogous to the great Rosedale iron-rock, which is sufficiently explained in the article to which we have above referred.

Mr. Bewick's plan of colouring green the strata covered by grass, etc., is an unscientific mode of overcoming a trifling difficulty; a short glance would have shown him, for example, that the village of Castleton rests on the Inferior Oolite. The granitic boulders are, in all probability, from Shap Fells, in Westmoreland, and not from Devonshire, as that author suggests. As a proof of Mr. Bewick's great enthusiasm, we may give his laborious calculations of the aggregate tonnage of iron-ore to be extracted from the whole of Cleveland; the figures are—for they are worth recording—4,820,000,000 tons; which, he adds, will suffice for treble the number of all the furnaces in Great Britain until A.D. 2,540! What will be done in January, 2,541, Mr. Bewick does not add. Such a calculation, however, although taken literally as a mere idle curiosity, will serve to express a practically unlimited supply, whilst we have no doubt but the higher seams will ere then be better known and more used. The Staiths' fishermen profess to know to a dozen the number of herrings on their coast, and we must class Mr. Bewick's calculations with theirs, as patterns of exactitude.

The map of Cleveland which accompanies the volume we can only admire for its neatness of execution, and express a wish that it had been more accurate: since a map of such dimensions ought to be of invaluable service in an examination of the geology of the district. In the first place, the basaltic dyke appears to have been dotted through the country about Danby without the slightest regard to accuracy; from Parke's Howe, at Fryup, to its appearance on the moor above Commondale, it is marked far to the south of its natural line. We notice the oolite colour covering many large tracts where the Lias shales most evidently exist; as, for example, in the Vale of Kempswithen, and part of Sleddale; the whole of Scugdale, Lownsdale, Northdale (Rosedale), the country near Ingleby Manor, between Little and Great Fryup at the head of the former, and near Swainby, as well as a large tract near Roseberry. To the south of Guisborough there is a similar error in colour, and countless instances along the sea-coast. The Trias and Lias are divided by a seemingly arbitrary boundary, very wide from the actual one, as near Eston Junction and at Hutton Rudby. The words "German Ocean" might mislead a stranger, by commencing, as they do, several miles up the river Tees; but we shall dismiss our corrections by a disproval of the entire neglect of such vast and important alluvial deposits, as are found at Saltburn, Runswick, Lealholme Bridge, and other places. A geological map, in our opinion, should mark the first geologic series beneath the superficial accumulations, and the one before us, if intended to do so, but ill fulfils the intention. In conclusion, we would recommend all who can to investigate for themselves one of the most interesting parts of England to the geological student.

THE GEOLOGIST.

APRIL, 1861.

A LECTURE ON "COAL."

By J. W. Salter, F.G.S.

(Continued from page 102.)

In many respects the plants and animals of the coal differ much from forms now living. It is probable that the greater part of them are even of different groups or families from the existing ones. But the ferns at least show strong traces of affinity. Here and there we meet with the young fern-leaves coiled up as they now lie on the heather, ready to unfold on the return of spring. We all know these "Bishops'

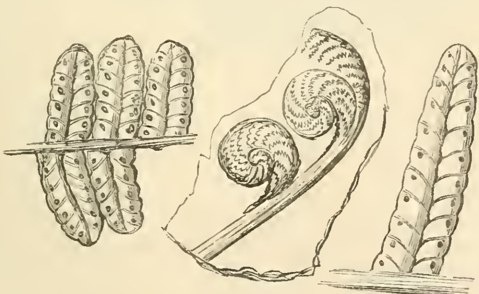


Fig. 1.—1. Curled up fronds (circinate) of Pecopteris (Brongniart).
2. 3, Fructification of ditto.

crooks" that nestle in the bottom of the fern-baskets; and when I saw a grand specimen in Mrs. Stackhouse Acton's cabinet (it now graces our museum in Jermyn Street), with the delicate coil of pinnæ, every leaflet in its place, I almost leaped for joy. It was from the Le Botwood coal-field. There is one figured in this work, vol. iii, p. 460 (but the finder has not yet been told, I think, what his fossil is): it is from South Wales, and a beautiful specimen.

Fig. 2. *Sphenopteris Schlotheimii*, a coal-fern from Strasbourg.

Our space was too crowded last month to give the necessary figures of the ferns; and it is but limited now. The leaves or fronds of the delicate *Sphenopteris*, mentioned p. 101, are very abundant. There are a number of species. *S. elegans*, *S. crassa*, and especially *S. affinis* occur in the lower coals, beneath the mountain limestone of Scotland;—*S. artemisiæfolia*, *S. Honinghausi*, *S. linearis*, *S. trifoliata*, are all characteristic of our upper coals, and the two last are found in France and Germany. Our figure represents the *Sp. Schlotheimii* of Brongniart, a plant that is found in the coal shales of Strasbourg.

The *Adiantites* of the Old Red Sandstone, mentioned last month, will be figured, and full descriptions given of it by the officers of the Irish Geological Survey; it is only, therefore, needful to give a sketch

Fig. 3.—Osmunda regalis, living at Killarney. To show the terminal fructification of the living fern.

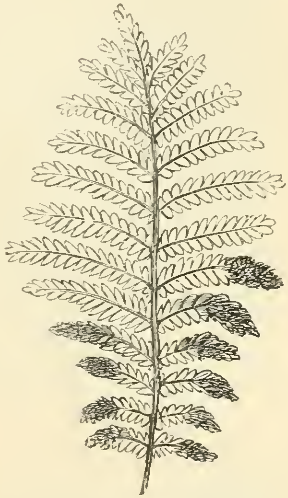


Fig. 4.—Adiantites Hibernicus, fossil in Kilkenny. To show the lateral spikes of fructification in the fossil.

figure of it here, especially as it does not actually belong to the coal, though the same genus is found there. We must now pass on from the ferns, and speak of the cylindrical stems so common in the coal.

The other plants of the coal, which strike us most, are the fluted stems called *Sigillaria.* They abound in all the shales, with every kind of varying proportion in the patterns, which nevertheless is of a regular and definite kind. It consists of longitudinal flutings, generally in right lines, sometimes a little zigzag; and on the surface of the flutings are scars, either round or somewhat kidney-shaped, or hexagonal—or even double ovals—or purse-shaped, narrower above than below, and always with a couple of dots in them, which are the marks of the vessels that supplied the leaves. For the scars are the bases of the leaves, which are seldom found; they are of a long shape, with a rib down the middle. The stems vary from a few inches broad to three feet in circumference, and specimens have been found that must once have been sixty feet long. They are generally quite flat in the shale, and often broken to pieces; and they are, most generally, covered with a coat of coal. The scars outside the coal-envelope are not quite the same as those which show within, but pretty nearly so. Our figure shows this (Fig. 5).

The Sigillaria was a tall tree, with a bare trunk regularly pitted by the leaf-scars. It branched at the summit, and bore long narrow leaves, as above said: its fruit is not known. Its internal structure has been examined in some very perfect specimens, by foreign and English botanists (fossil-botanists as some folks call them),—Brongniart, Hooker, Dawson, and others. It is a good deal like the *Cycas*, known in our green-houses as a Cape plant, but in some respects more like Ferns. Nor is there any living family of plants which tallies with it, though in a rough way it has been supposed by good judges to belong to the great tribe Coniferæ—to which our fir-trees, pines, cedars, and junipers belong. Hooker regards it as nearer the club-mosses, and especially near to *Lepidodendron*.

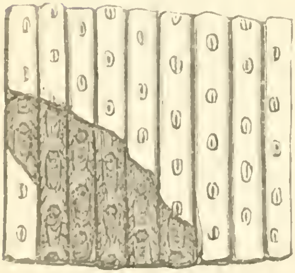


Fig. 5.—Sigillaria. Internal cast of stem, with portions of the bark, carbonised.

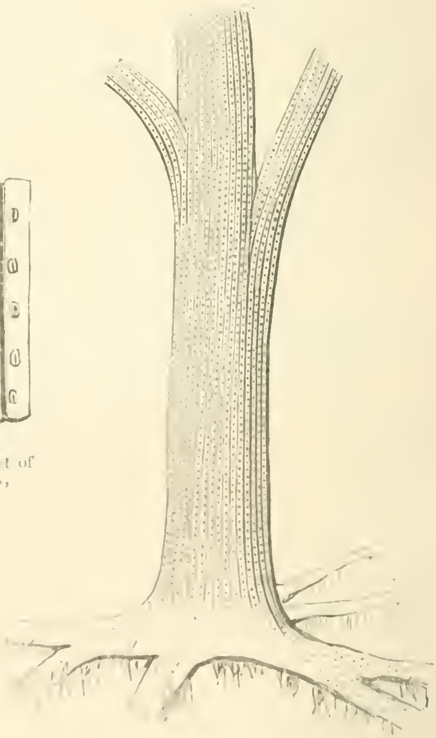


Fig. 6.—Sigillaria—the common coal-tree. Stem, perhaps 15 feet high; with its roots (Stigmaria) *b*.

The patterns on the bark differ in all the species, of which no less than fifteen are known in England alone. We have figured two of the more remarkable; and really they might be used for paperhangings in the studio of the geologist. Who will try copies from nature for this purpose?

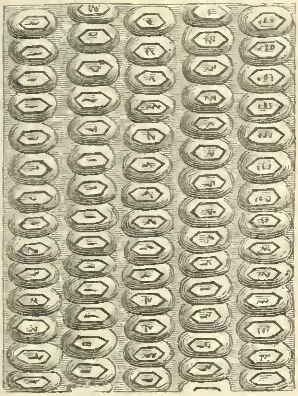


Fig. 7.—Sigillaria elegans.
Patterns of bark Sigillaria.

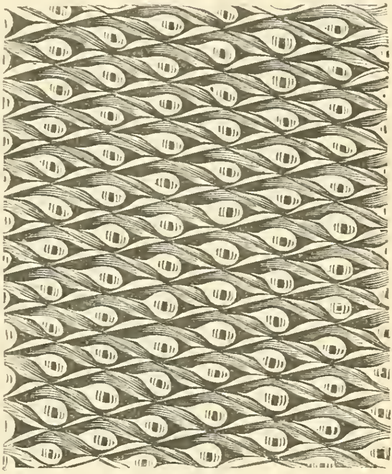


Fig. 8.—Sigillaria Defrancii.
Pattern of the markings on the bark.

But Sigillaria is not always found lying prostrate. It is very often upright, as it grew; so many instances are known of this that it is almost useless to repeat them. A stump, ten feet high, is figured in Dr. Mantell's "Wonders,"* a book worthy of every young geologist's ambition. Others have been noticed by Sir Charles Lyell, and a whole forest of short stumps was discovered in 1838, near Chesterfield, during the diggings for a railway. There were no less than forty trees—a few feet apart—on this one spot. In Durham, at Newcastle, and in the South Wales coal-basin, others have been found. Hugh Miller, in his interesting book—"First Impressions of England and the English," (p. 233)—has described his visit to the celebrated Wolverhampton coal-forest. Here seventy-three stumps, in three tiers, one over another, are closely packed: and three successive forests—on the same spot—seemed to him the best way of accounting for it. I think we have a better explanation; but I am not sure of that.

But, then, these trees have roots to them; and the discovery of these roots has opened up a new chapter in the history of coal. Nay, it has deciphered that history; for till Sir W. Logan found that every coal-bed had its underclay full of roots, and till Mr. W. E. Binney, of Manchester, traced these roots (which are called Stigmaria, (fig.), to their connection with the tree, we never truly knew how coal was formed.

* 2nd Edition.—By T. Rupert Jones, Esq., Vice-Sec. Geol. Society, 1858.

I ought to have said however, that the bark of the *Sigillaria* is in general the only part preserved. There was within it only a soft tissue of cells, with a central stem or axis of wood, the latter occupying but a small part of the cylinder. The soft tissue easily disappeared while fossilizing, or even before the tree fell, for we often find the stump filled with sand, and broken fragments of vegetables mixed within it. In one or two trees of this kind in the sandstone beds of Nova Scotia, Professor Dawson and Sir C. Lyell found a whole colony of centipedes or such like things, with snails and lizards! We must see how this happened when we come to the mode in which coal was deposited. The clay beneath the coal called an "underclay" just as the roof-shale is called "overclay"—is, as I have said, full of plants. These are the Stigmariæ, and our figure above shows what they are like. Now the great importance of Sir William's discovery was this,—that the only fossil found in the clay is, with the rarest exception, the Stigmaria; and it is invariably present. The fire-clay as it is called, is generally a pure sediment: and close upon it lies the coal, as pure coal as the other is clay. Now if we want to know what plant the coal is made of, we must certainly ask the under-clay where the roots grew; for there, if anywhere, we shall get an answer. Here Mr. Binney's discovery comes into play, for if Stigmaria is the root of Sigillaria—and is universal in the fire-clay—then, of course, Sigillaria is universal in the coal.

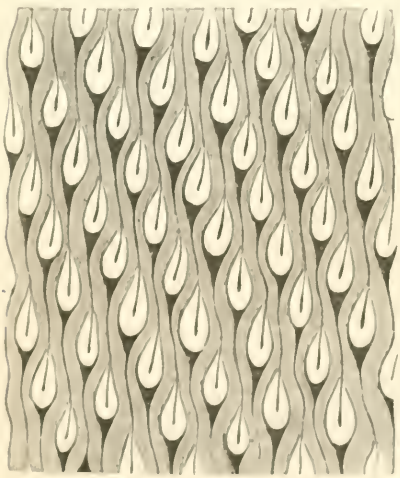


Fig. 9.—Pattern of bark (Lepidodendron).

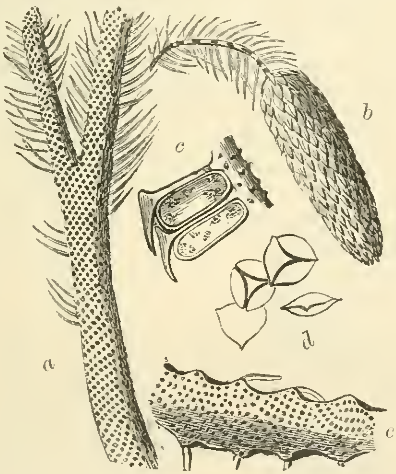
We have seen, too, that fragments of the *Sigillaria* trees are among the commonest in the shale that lies *above* the coal-bed. In truth the trees were higher than the depth of the coal-seam. Thus we may easily conceive that the roots of a tree may be *below* the coal—which is seldom above a few feet thick—the lower part of its stump fairly *in* the coal, and its bole and branches all *above*.

Thus it is we find the flattened stems, and thinner branches and leaves, so often in the roof shale.

There is another tree, *Lepidodendron*, whose roots we do not certainly know, but which appears to have grown in the underclay. It is almost as common as *Sigillaria*, and nearly as large. Perfect specimens have been found, forty feet in length from the soil to the end of the branches. But of course it is the rarest of things to meet with such trees.

Lepidodendron differed from Sigillaria in the arrangement of the leaf-scars, which pack closely in quincunx fashion over the surface. Our sketch shows this. The patterns are equally beautiful and as applicable to pictorial design as in the other case. The diamond shape of the scars will help you easily to recognise fragments.

There are many species of these trees. The commonest of all I think is the *L. Sternbergii*, of which a full length figure is to be found in the revised edition of Dr. Mantell's excellent book—"Jones's Wonders," as it ought to be called—p. 749. I have only given you fragments of branches, stems, leaves, fruit cones and their seeds or



Stem *(a)*, and leaves, catkin (*b*), seed-vessels (*c*), and seeds or spores *(d)* of Lepidodendron. We have added *(e)* its supposed root Halonia.

spores. It is well known now that Lepidostrobus *(b)* is the fruit or catkin of Lepidodendron. The little mountain club-moss, which rears its yellow catkins amid the sheltering boughs of the heather,—its stem clothed with long scale-like leaves,—is the best representative, in England at least, of these old giant forms, as large as forest-trees, which abounded so greatly in the times of the coal.

There is yet another plant, so very common in coal-shales, that it ought to be mentioned separately. I mean the *Calamites*. We have not space for a figure, and refer you to the book above quoted, p. 736, where the plant is, however, drawn upside down in fig. 3—quite right in figs 1 and 2. The look of these plants is so much that of the horsetail (Equisetum) of our ditches, that it is no wonder ordinary fossil-hunters should take them for blood-relations.

* And I have added the *Halonia*, which I fully believe to be the root of Lepidodendron.

Yet this plant was probably nearer to the great trees above-mentioned than anything else we can mention. The stem (or rather pith, for we do not see the stem itself in one case out of a hundred, but only the cast of the pith) is ribbed, and jointed just like Equisetum stems, but very rarely shows any leaves. Its leaves and branches were probably the plants called *Asterophyllites* and *Sphenophyllum*, and they look much like the "goose-grass" with which as schoolboys we used to bleed our tongues in sport. These two are very common. Some have broader leaves than others, and an American author of repute (Dr. Shumard, I believe) has seen reason to think that they were aquatic plants—that the broad leaves were the floating leaves, and the narrow ones the leaves that grew beneath the water. The common white buttercup which looks so gay in spring time on the ponds will serve to illustrate this supposition. Others do not think it quite a true one. To show how near some of these *Calamites* approach to the structure of ferns, I give here two cross sections, one of a tree fern, taken from Brongniart's work (Fig. 11), the other of the plant of a Calamite family (Fig. 12), figured by Dr.

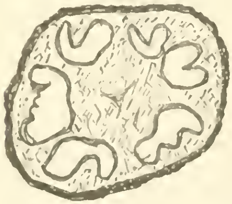


Fig. 11.—Section of tree fern, showing the large bundles of vessels.

Fig. 12.—Section of one of the Calamite tribe, showing the smaller bundles of vessels surrounding the pith.

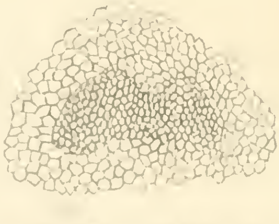


Fig. 13.—Portion of cross section magnified.

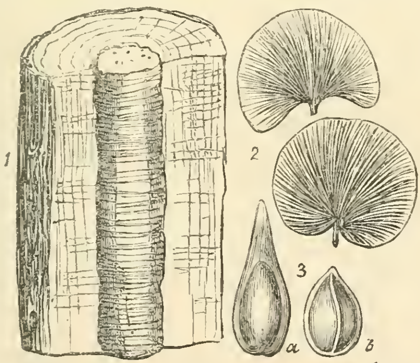
Unger, in a work on the fossil plants of Saxony. Fig 3 shows a portion of one of these cross sections magnified, the bundle of vessels among the cellular tissue.

Now then, for some real solid wooded trees—and with these we must finish—for the coal-flora after all was a scanty one compared with living nature. The individuals were abundant enough, but they were of comparatively few families of plants.

Fir trees of one sort or another were abundant in the coal-period, and have been so in every succeeding formation. But here, as in every other case, the coal-trees were different from the modern ones. Now we have abundant spruce, and larch, and fir; junipers, and cypress trees, and yews; and in the tertiary and oolitic times these were common trees. But the *Araucaria* tribe, to which the graceful Norfolk Island pine belongs, is only to be met with rarely. At least it is confined to a small portion of the globe. In the coal time it was the prevailing form. There is no need to give a drawing of the structure of this wood, for it has been given by every author who has written on the coal.

Wood is made up long fibres, which fibres communicate with each other by pores. The wood of coniferous trees is specially remarkable for the large disks which surround these pores. They are disposed in straight rows, and most of the *Coniferæ* have only a single row. But the *Araucariæ* have a double row—or more than a double row; and all the coal fir-trees are of this kind.

Again there is a remarkable difference between the coal-trees and their living representatives. In no living fir-tree does the pith show of any size, except in quite the young shoots. After that age it gradually diminishes in diameter, or rather does not increase with the growth of the tree, being pressed upon by the successive layers of the



Coniferous wood (Dadoxylon), with its pith, Sternbergia leaves (Cyclopteris), probably of the same coniferous tree; fruit and seeds (Trigonocarpum) of the same.

wood, till in a cross cut of a piece of fir a mere trace of this substance, so important in the first stages of the young branch, is to be seen. The case is different with the old fir-trees of the coal. Here (according to the excellent observations of Dr. Williamson, of Manchester), the pith is of enormous size, and retains that size during the after-stages of growth, if it does not actually increase. It was long ago known under the name of *Sternbergia*, and is often as thick as a large man's thumb, or even thicker. I have seen some as thick as a child's wrist.

Dr. Williamson found that this pith was imbedded in a wood which was in all respects a true fir-tree, and which has been known under the name of *Dadoxylon*. It is not certain that all the firs belonged to this one genus; most probably they did not. At all events Dadoxylon is a very common coal-fossil.

Here then we have the wood and the pith; and let me say that any one who is disposed to examine the contents of his own coal scuttle may do so with advantage, for the charcoal he will find in it shows, under the microscope, a beautiful tissue like that described above. As an opaque object it is very beautiful, and polished slices sometimes show it equally well. Prof. Queckett, of the College of Surgeons, has distinguished himself for his researches into these tissues, and in the wonderful "Torbane Hill case," referred to in the opening of this lecture, his skill was largely called into requisition.

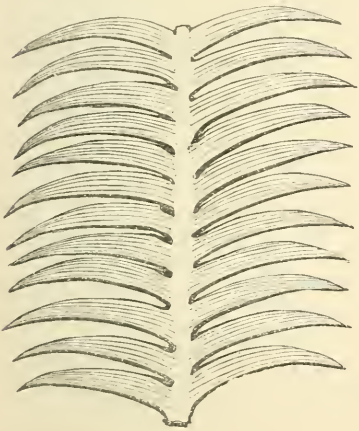
But having got the wood, one naturally wishes to find the leaves and seeds. What were they?

Some years back a suspicion entered my mind that the leaves commonly called *Cyclopteris* might belong to this family of trees. It is true they might be ferns, to which order they have been usually referred. But there are fir-trees, or at least Coniferæ, which have broad leaves very much of the shape of these supposed ferns. Heart-shaped or fan-shaped leaves, with a shorter or longer stalk, and the veins so like that of the fern, that it is difficult to distinguish fragments. These are the *Salisburia*. They are trees well known in our parks and gardens, and there is a noble specimen at Kew. Let anyone compare a figure of the *Cyclopteris* of the coal with a leaf of the living *Salisburia*, and he will be struck with the strong resemblance. The possibility of this has of course occurred to those skilled botanists who have written on coal-plants; but none of them have, I think, been rash enough to call the *Cyclopteris* the leaf of *Dadoxylon*, or to suggest, as I do now, that many of the leaves called *Noggerathia*, and even some called *Adiantites* are nothing more or less than leaves of the coniferous trees, which we know abounded in these old forests.

It is otherwise with the fruit. Professor Henslow some time back showed me the fruit of *Salisburia*, and compared it with the *Trigonocarpon* from the Manchester coal-sandstone. And Dr. Hooker, by a series of original researches into these coal-nuts (published in the Royal Society's Transactions), has demonstrated that they are the fruits or nuts of coniferous trees, each with a large fleshy envelope like the fruit of the yew. Well then, if Dadoxylon is the common fir-wood of the coal, and *Trigonocarpum* the common coal fruit, we need only put two and two together; and if we cannot convince the cautious botanists, I hope I may convince my student readers there is a strong probability that the one is the fruit of the other.

Coal pine-trees; coal pine-leaves, and coal pine-fruit! We are getting on. But this is not quite all. The same distinguished botanist to whom I have so often referred (who has shown us the true structure of the *Lepidodendron* and its seed; and has illustrated the fruit of these old fir-trees), suggested years ago, in the gallery of the Museum of Practical Geology, that the one supposed *flower* of the coal belonged to the fir tribe too.

It is called *Antholites*, and may, as he admits, certainly be what it was at first described to be—the flower spike of a plant not distantly related to the pine apple! There are some prickly leaves (if they be not fern-stalks) in the coal-shales, which render this possible,—not, I think, probable.



Cycadeous Plant (Pterophyllum), from the carboniferous beds of the Altai Mountains.

But on the other hand these so-called flowers have no very regular parts, and are not a bit like any living ones that I know. They look to me, as they did to Dr. Hooker when he first examined them, very like unfolding buds of Coniferæ, with somewhat broader leaves than we are accustomed to see in modern firs or larch, but not broader than many of the yew tribe. As I do not know that the author I have named still holds the original opinion, I do not quote him for it; but only give my own.

Of the Cycas tribe, so abundant in oolitic times, a few representatives occur. They are not characteristic of the coal, and are rare in England. We give a foreign specimen.

And now a few grass-like plants, of whose nature we cannot say much, for want of the fructification, would end the series, had it not been known that they are *fungi* in the coal! I know but little about them, and will therefore say less; but there they are—three species.

Of the animals of the coal I shall have a little to say next month, when I hope to finish this rather lengthy lecture. I am not tired of it myself, but our young readers may be.

SOME REMARKS ON MR. DARWIN'S THEORY.

By Frederick Wollaston Hutton, F.G.S.

> I said that "all the years invent;
> Each month is various to present
> The world with some development."—*Tennyson*.

Although most of my readers will be perfectly acquainted with the theory proposed by Mr. Darwin to account for the various forms of life that we see on the globe, yet, for the sake of clearness, I will briefly enunciate it.

Mr. Darwin first shows that individuals of the same species vary one with another.

He then shows that, owing to the rapid increase of animal and vegetable life, by which many more are born each year than can possibly survive, there is a continual warfare going on among them for food and other necessaries. This he calls the "struggle for life."

He then shows that if any animal or plant should have, by variation, any organ or property so modified as to give it some advantage over its fellows in the struggle for life, it will, as a general rule, live longer and produce more offspring; and these offspring will have a tendency to inherit the organ or property modified in the same manner: but if in one of these offspring the organ should be still further modified, it will give him a like advantage over his brethren, and his offspring again will have a tendency to reproduce the organ in its more modified state; and so on. This he calls "Natural Selection."

Mr. Darwin thinks that this, together with the minor causes of habit, use and disuse, climate, &c., are sufficient to account for all the various forms of organic life, by the gradual transmutation of one species into another.

As all naturalists allow that species vary, it seems that the difference in the opinions of some of them on this subject arise on the question of limits. Are these varieties of species limited, or are they unlimited?

A limiting value of a variable is a quantity to which the variable may approach ever so near, but never reach; if therefore it can be shown that there is a limiting value to the variation of species, Mr. Darwin's theory could not be extended beyond that limit. At present no one has been able to assign to it any limits at all; in fact it will be a very difficult thing to do so, for it would be of no use to prove that any one organ of a particular animal could not change into the rare organ of another particular animal, as it is never supposed that the higher form of life has passed through every lower form; for the same reason that the sap which nourishes one leaf of a tree has not passed through all the other leaves.

The way this question has generally been argued is, not by trying to define any one strict limit beyond which variation cannot pass, but by trying to show that there are reasons for believing that a limit does exist somewhere. The following are the most important ones that have been brought forward to this effect.

1. All varieties made by man, if left to themselves, show a tendency to revert to the original forms; while natural species do not.
2. All varieties made by man interbreed freely, while natural species do not.
3. Species remain constant for immense periods of time, as is proved by the exact resemblance of the mummies of Egypt, and many fossils, to living forms.
4. Some genera, as Lingula, &c., have existed with very little variation from the most ancient times to the present.
5. Instead of progressing, some animals seem to have degenerated; as the recent armadillo from the glyptodon, &c.
6. We have no right to argue on domestic breeds, since they have been chosen on account of their plasticity.

I will now give answers that have been made to these objections.

1. It cannot be proved that many of our domestic animals revert to their original forms when left to themselves; for it has always been found impossible to say what their original forms were: but if this was the case, a simple experiment would decide. Recent varieties certainly do show this tendency, because of the extremely short time during which selection has been going on; and the rapidity, owing to artificial causes, in which the change took place. In a wild state the changes progress very slowly by natural causes, and therefore by the time a variety has changed sufficiently to be called a new species, it has given up all thought (if I may so express myself) of reverting to its original form.
2. "Man can hardly, or only with great difficulty, select any deviation of structure, except such as are externally visible, and he rarely cares for what is internal." Besides, the varieties formed by man have only been in existence for a few thousand years, while natural species have been so for hundreds of thousands; for until they have been formed long enough to deviate markedly from other species they are only called varieties.
3. The answer to this argument is that they have not yet had time to change, owing to their conditions of life not having been much altered. The mummies of Egypt are perhaps four thousand years old, but Mr. L. Horner, the President of the Geological Society, has shown that man, sufficiently civilized to manufacture pottery, existed in the valley of the Nile thirteen or fourteen thousand years ago. And the same with the fossils; as we go further back in time we see living forms get rarer and rarer until at last they die out altogether. If a form has managed to exist for a long time without change, it is

triumphantly produced by the anti-transmutationists; if, on the contrary, it has changed in ever so slight a degree from an extinct form it is called a new species.

4. Suppose a large area covered with sea, and Lingula, &c., spread over it. Now suppose a part of this area to be gradually elevated, the Lingulæ and other animals living on it would undergo variation to meet the change of conditions; but those on the stationary area would remain constant. Next suppose the elevated part to sink again: the new forms on it must either die out or change, and the Lingulæ would again spread over the whole area; and being better adapted to those conditions, from long residence in them, would kill off, perhaps, some of the new forms. Again, another part of the area might be raised; and so on. The chances are that some of the Lingulæ would always be on a stationary portion, and thus hand down their offspring with little variation, for any length of time. It is a fact which strongly corroborates this, that nearly all the genera which have a long range in time are inhabitants of the deep sea, and therefore have also a large range in space.
5. It is not supposed that the armadillo is descended from the glyptodon; on the contrary the latter seems to have become extinct, and to have left no progeny, while some other form may have been the progenitor of the former.
6. "On the contrary domestic breeds show all degrees of variation, as the pigeon, dog, &c., on one side, and the cat and goose on the other. Perhaps there is not much difference of variability in animals, constancy can generally be accounted for; pigeons can be mated for life, and are kept in large quantities, and therefore vary much; cats ramble at night and cannot be watched, and are kept in small quantities; donkeys and peacocks are also kept in small quantities, and the breeding of donkeys is not much cared for; geese are only valued for two purposes, food and feathers, and no pleasure seems to have been felt for different breeds."

Let us now see what reasons there are for supposing that variation is *at present* unlimited; or, in other words, that all animals have descended from a common prototype. By admitting it to be true we can easily understand—

1. Why species have come into the world slowly and successively.
2. Why "the families of each division (of moluscs) which are least unlike (*Orthoceratidæ* and *Belemnitidæ*) were respectively the first developed.*
3. Why species have not necessarily changed together, or at the same rate, or in the same degree: yet in the long run all *have* undergone modification to some extent.

* Woodward's "Recent and Fossil Shells," p. 417

4. Why the extinction of old forms is the almost inevitable consequence of the production of new ones.
5. Why, when a species disappears, it never re-appears (although this is within the range of possibility).
6. Why groups of species increase in number slowly, and endure for unequal periods of time.
7. Why, the more ancient a form is, the more it generally differs from those now living.
8. Why all the forms of life are linked together.
9. Why there is often great difficulty in drawing a line between two species.
10. Why, as a general rule, in life on the globe there have been "an ascent, and progress in the main."
11. Why the lower forms of life have larger specific existences than the higher ones*.
12. Why the older forms lived unchanged for longer periods of time than the newer ones, † because they were more widely distributed.
13. Why the deep-sea shells and those of the land and fresh-water enjoy a longer range in time than the littoral species; for the littoral species being confined to narrow zones in depth are much more likely to suffer from elevation or subsidence than those that live in the deep-sea, or on the land and in fresh-water.
14. Why some animals and plants have rudimentary, and sometimes useless organs.
15. Why the homologous parts, so different in the adult, are alike in the embryo.
16. Why the embryos of the higher animals resemble, at different stages of their existence, the embryos of the lower animals.‡
17. Why "in their infancy the molluscous animals are more alike, both in appearance and habits, than in after life.§"
18. Why the limbs, &c., of all animals are formed on the same plan.
19. Why the flowers, branches, &c., of plants and trees are but rudimentary or metamorphosed leaves.||
20. Why animals very often resemble in colour and appearance the localities which they frequent.
21. Why in geographical distribution there are generic as well as specific centres.
22. Why typical groups and species are widely distributed, while aberrant forms are usually confined to small areas.
23. Why the inhabitants of islands bear some relation to those of the nearest continent.

* Owen's Palæontology, p. 49.
†Anniversary Address of Professor Phillips to the Geological Society in Feb. 1860
‡ Carpenter's "Principles of Comparative Physiology," p. 95.
§ Woodward's "Recent and Fossil Shells," p. 10.
|| Lindley's "Elements of Botany," p. 354.

24. Why the extinct fauna of a country bears a close analogy to the living fauna.
25. Why the proportion of species increases from the oldest formations to the newest.
26. Why species were more widely distributed formerly than now; for as more species were developed, the more local they must have become.

I know of no answers to these arguments; they are simply facts acknowledged by everybody, except perhaps those for which I have given my authority.

Taking everything then into consideration, I think that the evidence is greatly in favour of variation being at present unlimited.*

The second argument against Mr. Darwin's theory is that natural selection, although allowed to be a "vera causa" of variation, is not powerful enough to produce the great differences that exist among organic forms; or, in other words, that the cause is not equal to the effect.

The cause may be compared to the power of a machine that has to be increased or diminished according as the time in which it is required to produce a given effect is shortened or lengthened. I believe that no one but a geologist has any conception of the enormous length of time comprehended in the term "geological period;" and, although all or nearly all of my readers will be geologists, yet I think that it will perhaps be as well to try to get some very rough idea of it, especially as "time" has been brought forward in answer to other arguments.

Mr. Darwin has shown that for long periods of geological time volcanic action has been pretty regular and persistent beneath Chili, and that the average elevation of the coast is about three feet in a century;† but in the "Pampean mud," in which the remains of Megatherium, Mylodon, &c., are found, is sometimes twelve thousand feet above the level of the sea; this would make its age four hundred thousand years, yet it is only of Pleistocene age, and was formed perhaps since man inhabited the globe. How old then is the Pliocene? How old the Eocene? How old the chalk? Ten million years is the least that can represent it; and yet it is not more than a twenty-fifth part of the thickness of the sedimentary strata of Great Britain.

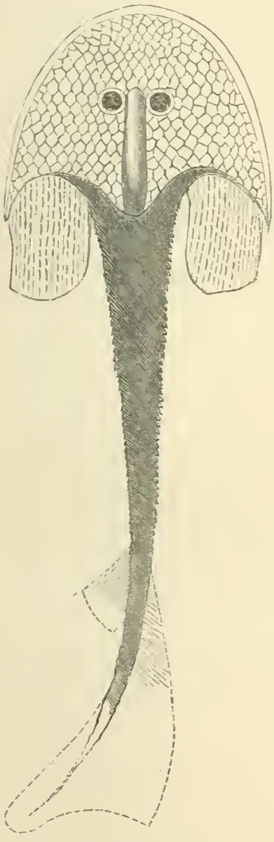
In such an enormous time, then, how small may have been the cause of the gradual change of the lowest form of life into the highest?—much less than a struggle for life or death.

* By at present unlimited, I mean that there is no limit between the lowest and the highest known forms of life, but beyond the highest there may be a limit to which we are approaching.

† Proceedings of the Geological Society, vol. ii., p. 446, and Darwin's "Geology of South America." London: 1846.

(To be Continued.)

CEPHALASPIDES OF FORFARSHIRE.



Cephalaspis in Mr. Powrie's collection.

SIR,—The communication in your number for this month (March) from Mr. G. Roberts, in which he carefully conducts the enquiring geologist over some of the most interesting Silurian and Old Red Sandstone districts in England, and clearly points out the places where the remains of these curious primeval fishes, the Cephalaspides, are to be looked for, makes me think that a short notice of what Forfarshire has done towards bettering our acquaintance with at least one of these fishes, the Cephalaspis, may not be uninteresting; for, although, fortunately for geology, Scotland has now no monopoly of Old Red Sandstone fishes, yet so far as I am aware no really perfect specimen of that fish has been found out of this county. In forwarding this notice, I can assure the reader that I am actuated by no desire to have my name in any way connected with "a memoir of the earliest known fish," or "the history of the first appearance of vertebrated life," my sole motive being, by giving so far as I can, a popular description of what is known of the Cephalaspis, to fan the by no means flagging zeal of local collectors to complete our knowledge of this queer fish, and its congeners.

Although tolerably well-preserved specimens of the Cephalic shield which covered the head of the Cephalaspis, are by no means rare, yet it is very seldom indeed that the body is disinterred from our rocks; and as I do not recollect of more than the head of this fish having been figured in "THE GEOLOGIST," I prefix a rough pen and ink sketch of a rather complete specimen from my own collection, reduced to one half the natural size.

The very characteristic strong bony shield which protects the head, and from which the creature takes its name (being made up of two Greek words signifying a head and a shield), had been covered externally by small hexagonal ganoid scales. Near the centre of this shield two rather closely placed holes formed the orbits for the eyes. In one of the heads in my possession the eye-balls are finely preserved completely petrified; between the eyes were two ridges having an intermediate hollow or sinus extending from the eyes backwards. One of my specimens shows that these ridges united towards the posterior edge of the shield, forming evidently a strong defence. None of the many heads I have examined show the slightest evidence that this creature was possessed of teeth, or a mouth of the ordinary form; this organ, I believe, being similar to the sturgeon, which royal fish, I have little doubt, had this comparatively small creature as its representative in these old world waters. Some of the cusps or sharpened points of the shield are very much elongated and toothed on the interior of the margin. The body as compared with the head was but small, very slender, and protected by bony rings, extending in a slanting direction from the back downwards, these again being covered by exceedingly minute rhomboidal scales; in this respect resembling the larger number of the fishes found in the lower beds of the Forfarshire Old Red, as *Climatius*, *Acanthodes*, *Diplacanthus*, &c. In only one specimen have I ever observed these on all scales; but a portion of one in my possession shows a very perfectly preserved cast of them: its heterocercal tail was much produced and furnished with a very large and powerful fin. None of the specimens I have as yet examined show the slightest vestige of either anal or ventral fins. The existence of a dorsal is by no means established; had it existed it must have occupied a position very far back. This creature was, however, further remarkable for having two very large membranous pectorals, attached immediately under the cephalic buckler, seemingly of a leathery consistence, and covered by small sub-circular or hexagonal scales. The pectorals were first discovered by me, in the specimen from which the figure is copied.

The remains of Cephalaspis, generally associated with plates or other portions of the *Pterygotus Anglicus*, have been found in almost all the places where the grey flagstones, generally known in commerce as the Arbroath pavement, and which crop out in so many localities in Forfarshire, have been wrought. It has also been found in a bright red micaceous sandstone, overlying and considerably above these flagstones, while in no case has the *Pterygotus Anglicus* been, up to this time, found in the sandstones overlying the shales and flagstones of the Arbroath pavement. Although the above-mentioned flagstones are quarried in so very many places in Forfarshire, anything approaching to a complete specimen of this fish very rarely turns up indeed. I only know of some eight or ten specimens showing the body, having been as yet disinterred from the rocks in which they have so long been intombed. Perhaps the finest of these was several years ago got by the late Mr. Lindsay Carnegie from his quarries at Leysmill, and by him presented to the Arbroath Museum. The well-known specimen presented by Sir Charles Lyell to the British Museum was found in a quarry near the village of Glammis. There are three good specimens in the Montrose Museum, one of which was discovered in a quarry near Brechin; another is from the neighbourhood of Friockheim. I have also been able to secure three specimens in tolerable preservation. Two of these were found in a quarry at Legguston, near Friockheim. The only other specimen I know of, a very small one picked up by Mr. Walter McNicoll, in a singularly rich deposit discovered by him in the Sidlaw range, is now in the cabinet of Lord Kinnaird. As already stated the buckler-shaped heads are occasionally met with wherever the flagstones are wrought, in some places rather plentifully, as in a quarry on the Tur hill range, about a mile east from the Mansion House of Pitscandly, also in a Red Sandstone quarry near Brechin; yet even there these are only to be had by getting the workmen to preserve them as they turn up. Indeed I may say that the only locality which has as yet yielded these organisms to individual research is mentioned as discovered in the Sidlaws by Mr. Walter McNicholl, one of the most energetic and consequently successful of our local explorers. On the same slab on which Mr. McNicholl found the small entire Cephalaspis noticed above, may be seen the heads of some four or five others, some of these heads showing the very lengthened and toothed cusps above described.

Whether these lengthened and toothed cusps may mark a different species from that generally found (*Cephalaspis Lyellii*) it is not my province to decide: my own impression however is that this rather points to difference in age or sex, most probably the latter. Should this be the case it is worthy of remark that only one species of Cephalaspis has yet been found in Forfarshire (in Scotland I ought rather to say), where the remains of these curious creatures have been found in comparative abundance and good preservation, while in the contemporaneous rocks of England, where, so far as I am aware, they are both rarer and much more fragmentary, there would seem to have been not only a considerable number of different species detected, but also the so nearly allied genus *Auchenaspis*. Could it be possible that the above causes, age or sex, should have occasioned this seeming variety of species—fracture and displacement of the parts when first laid down might also occasion very considerable apparent divergence.

Beyond Forfarshire I only know of one locality that has been at all fruitful in these organisms, the well-known den of Balruddery, and this is just on the confines of the counties of Perth and Forfar. One or two heads have also been found in Canterland Den, in Kincardineshire, by the Rev. Hugh Mitchell, of Craig, A quarry in Sheriffmuir, not far from the Dunblane station of the Scottish Midland Railway, has yielded one imperfect head; and two have been got at Langfine, near Muirkirk, in Ayrshire. In no case has an entire fish been found in any of these localities.

In this short notice of the Forfarshire Cephalaspis I have purposely endeavoured, as far as I could, to avoid all scientific names and phrases, so that my description might be as intelligible as possible to all your readers. I ought also to remark that although the proportions and position, &c., of the fish figured are as nearly as may be those of the specimen from which it is copied, other specimens show a considerably stouter body. The scales are of course restored, only small patches of these being preserved on any of the specimens. The dotted lines meant to show the probable size of the caudal and dorsal fins, unless, indeed, that figured as a dorsal had really formed only part of the large tail-fin.—I am, your obedient servant, JAS. POWRIE, F.G.S., Reswallie, Forfar.

REMARKS ON MR. ROBERTS' PAPER ON CEPHALASPIS.

SIR,—I venture to send you a few comments on Mr. George Roberts's paper on Cephalaspis in your last number.

How your correspondent, Mr. G. E. Roberts, can talk (page 103) of the Lower Ludlow at Leintwardine being "clearly marked out as a littoral deposit" by its "starfishes," after his paper in the "GEOLOGIST" the other day announcing the discovery of starfish at one thousand two hundred and sixty fathoms depth, surprises me much.

Equally does it surprise me (especially since his connexion with the Geological Society) to find him talking of the "Tilestone series passing into the underlying Silurian," when Sir R. Murchison, in his last edition of Siluria, has laid down (though, I confess, with a little confusion) that the beds between the Old Red and the Silurian are to be called *Passage beds*, and are quite different from his original Tilestones, which are clearly Upper Ludlow, being Downton Sandstone. As long as this inattention to proper nomenclature is perpetuated, no one can understand what is written on the subject.

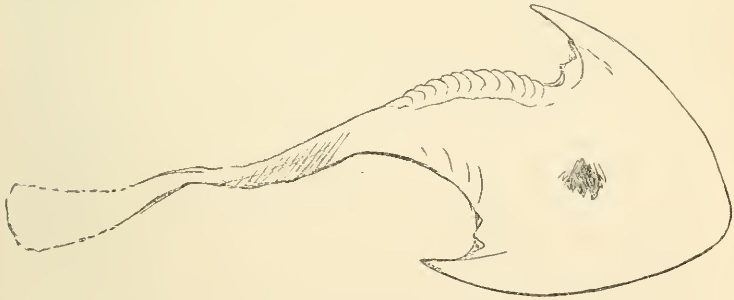
The chief cause of error seems to lie in the end of the tenth chapter of Siluria, which appears to have been written before the present knowledge on the subject was obtained, and not corrected before sending it to press. The author there certainly speaks of the Tilestones and Passage beds of Kington in connexion with Mr. Banks; but those beds at Bradnor Hill are unquestionably Downton Sandstone. They were formerly by some called "Transition beds" (as marking the change to sandy from shaley beds), and were *then* considered to be equivalent to the Tilestones of Murchison, and which Tilestones were afterwards considered by some to be the same as the Passage beds, which, in fact, lie some distance above them. There is no excuse for the mistake on the part of my friend Roberts, who knows both series of beds well, and I am sure can see no similarity between them. In fact (at page 106), he calls the Kington beds Downton, but oddly enough distinguishes between the Downton beds and the Upper Ludlow, of which they are the top. In the same page (at top) he speaks of Cephalaspids being "abundant in the *neutral* ground between the Downton and the Tilestones," which puzzles me, as I am not aware of any such neutral ground, the one being always supposed to follow the other consecutively.

Again, he mistakes in calling beds in the quarry in the drive to Downton Hall (at bottom of page) Tilestones. They are unquestionably Old Red beds of thick sandstone, and with the same cornstone as he found at the Devil's mouth, containing *Cephalaspis Lyellii* and *Pteraspis rostratus*.

I will take this opportunity of noticing that my friend Marston has made little mistake in his list of fossils from the Old Red near Ludlow. I will venture to assert that no *Cephalaspis Salweyi* has ever been found in Oakley Park quarry, which lies in the lower beds of the Old Red, probably but little above the Passage beds. It does contain a Cephaspid, but as yet it is unnamed, and the original specimen of *C. Salweyi* came from beds very much higher up, at Acton Beauchamp, near Bromyard.—I remain, dear Sir, yours obediently, ROBERT LIGHTBODY, Ludlow.

CEPHALASPIS FROM OLD RED SANDSTONE NEAR LUDLOW.

WE think it a very necessary appendix to the above correspondence on Mr. Roberts' article to give an outline figure of a very nearly perfect Cephalaspis Lyellii, found in the Old Red Sandstone strata near Ludlow, by Mr. A. Marston, who kindly transmitted it to us in October last, with another large and more beautifully preserved head.



Cephalaspis from Old Red near Ludlow.

These specimens we have just forwarded to Mr. Salter, so we may hope for a full and efficient notice of them in the forthcoming monograph of the Government paleontologists on these ancient fishes.—ED. GEOL.

FOREIGN CORRESPONDENCE.

On the Silurian "Colonies" of Bohemia. By Mr. M. V. Lipold.

Certain strata of greenstones, graptolite-shales, and concretionary limestones, petrographically and palæontologically analogous to M. Barrande's "superior Silurian étage E" ("Litten-strata" of the geologists of the Vienna Imperial Institute), but appearing in isolated lenticular masses between the slates and quartzite-sandstones of his "Lower Silurian étage D," have been pronounced by M. Barrande to be "colonies," the fauna of which, already existing in a distant sea at the period when the strata of the "étage D" were forming on the present Silurian region of Central Bohemia, had immigrated thither under favourable conditions, and had subsequently disappeared, together with these conditions, to reappear again and come to its full development after the strata of "étage D" had been completely deposited at the bottom of the Silurian sea. Prof. Krejcy, of Prague, having co-operated as a volunteer with the geologists of the Imperial Institute in the survey of the environs of Prague and Beraun during the summer of 1859, has made some objection to the explanation of the above-mentioned facts as given by M. Barrande, as, according to his views, they could be very well accounted for by upheaval and disturbances which had affected the upper and lower strata of Bohemia. M. Barrande, having protested against this assertion, M. Lipold was entrusted by Director Haidinger with the close examination of one or more of M. Barrande's "colonies." The results of this examination, made in the summer of 1860, are given in the present report. M. Lipold closely examined the "colonies" named in honour of MM. Haidinger and Krejcy,* south of Prague, near Gros-kuckel, lying within the slates and quartzite-sandstones ("Königshof" and "Kossow" strata of the Vienna geologists) of M. Barrande's "étage D," division D^5, and re-examined with "scrupulous" attention Prof Krejcy's survey on the south margin of the Upper Silurians, proceeding south-westward from Gross Kuckel to the environs of Litten, along a line of about fourteen English miles in length. The facts stated by this survey are traced on two geological maps, and on a series of sections. They show the "Königshof" and "Kossow strata" on the south margin of the Upper Silurians, together with the "Litten strata," to have undergone repeated foldings and dislocations. Two such foldings and dislocations of the "Königshof" and "Kossow-strata," extending

* Since this time M. Barrande has delivered to the Géol. Soc. of France (meeting of June 4th, 1860) a paper on "Colonies," and read an abstract of it concerning the colonies "Haidinger" and "Krejcy." (See Bulletin de la Société Géologique de France, 2e serie, t. xvii., p. 302.)

north-east to south-west, as far as Litten, coming to the surface south-westward in zones gradually narrowing and disappearing near Litten, beneath the Litten strata, are particularly conspicuous. On the other hand, the "Litten strata" very extensive, and totally overlaid by Upper Silurian limestones in the vicinity of this place, begin there to be divided into two stripes, intercalated in the foldings of "Königshof" and "Kossow strata," decreasing in breadth as they proceed north-eastward, and at last totally disappearing between Harlik and Wonoklas.

Isolated portions and zones of "Litten strata," intercalated between "Königshof" and "Kossow strata" occur again in the same north-east direction, near Wonoklas, Cersonic, Kosor, Radotin, and Gross Kuckel (colonies "Haidinger" and "Krejcy"); so that a connection of both these "colonies" with the above-mentioned two zones of Litten strata intercalated between the foldings of Königshof and Kossow strata can no longer be a subject of doubt.

The colonies "Haidinger" and "Krejcy," where beside the Litten strata appear not in conformable but in disturbed stratification between the Königshof and Kossow strata must therefore be considered as remains of a once more extensive deposit, forced between these last strata by the foldings and dislocations they had undergone. Without the least depreciation of the services which geology owes to M. Barrande, the sagacious and indefatigable explorer of the Silurian strata in the centre of Bohemia, the facts just mentioned must be acknowledged to corroborate Prof. Krejcy's theory of dislocations being the real cause of the palæontological abnormities comprised under the general denomination of "Silurian colonies." The "colony" named in honour to Prof. Zippe, although at present inaccessible to investigation, may be supposed, by analogy, to afford new facts in favour of this theory.

On the Red Chromate of Lead, and useful Minerals of the Philippine Islands. By W. W. Wood, Esq.

Specimens of the red chromate of lead from the Labo mines in the province of North Carnarines (Isle of Luzon), obtained by Prof. Hochstetter, through Mr. W. W. Wood's (of Manilla) kindness, have been examined by M. Dauber (Academical Proc. No. 21, 1860, p. 21), Mr. W. W. Wood, at Dir. Haidinger's request, gave the following details about this interesting mineral, and the useful minerals of the Phillipine Islands. The chromate of lead was discovered accidently, and was dug out in considerable quantity; the diggings, however, having been subsequently filled up, it is not at present to be obtained, and little is known about it at Manilla. It was afterwards found again in small quantities near the first locality. A Spanish mining-engineer, who visited the Luzon about three years ago, reported it to be very scarce and to be with difficulty obtained.

There are but very few mines in the island. A very rich deposit of argentiferous galena, found in North Caranines, is said to be now abandoned after having been exploited for some time by a Spanish company.

The quartz of this province, and nearly all the rivers, are auriferous. A gold mine in quartz, drowned by water, lay abandoned for a long time, until a Spanish company tried to make it accessible by driving a gallery, but this project was abandoned in consequence of heavy losses.

Excellent iron, worked in a very primitive way, is found in the province of Bulacon (north of Manilla). Fine magnetic iron-ore occurs also. Grey sulphuret of copper is exploited in the northern part of Luzon, both by natives (who bring the metal to the coast in small shapeless cakes), and by a Spanish company. Native mercury not associated with cinnabar, occurs in black magnetic iron-sand at Albay (East Luzon). Coal exists in the inaccessible localities of North Carnarines, and in the Isle of Leba, north of Mindanao. Platinum is said to occur in a brook coming from the hill of St Mablo, near Manilla. A Spanish company exploiting the copper occurring in rolled pebbles on the Isle of Samar (south-east of Luzon), could not cover their expenses. As to the red chromate of lead, it had been discovered by Don Isidro de Baaranda, of Madrid, who brought to England the finest specimens of this mineral. Its scarcity is accounted for by the circumstance that the natives near the Leba gather the small crystals of it and crush them to powder, to strew over newly written letters.

New Fossils from Radoboy and Trieste.

Remains of *Delphinopsis Freyeri* have been found in the Tertiary beds of Radoboj (Croatia)—so well known for their abundance of fossil plants and insects. A tooth of a *Rhinoceros*, different from *Rh. tichorhinus*, and resembling the *Rh. Merckii*, from Daxland, near Carlsruhe, has been found in a cave recently discovered near Matterie, two Austrian miles from Trieste.

Stoliezker on the Fossil Molusca of the Hierlatry (Middle Lias) Strata.

Among the seventy-two species of moluses (fifty-four Gasteropoda and eighteen Acephala), occurring in these beds of the east Alpine region, eighteen are identical with the forms known from the middle Lias of Fontaine-Elonpefour, and the Chalons-sur-Saone (Normandy), eighteen with German forms, and forty-eight species have not been described Six species only occur simultaneously in the German, Alpine, and French Lias; some of them are also known to occur in the coeval strata of England.

Secondary Rocks of Portugal.

Prof. E. Suess, on examining a large collection of fossil Brachiopoda from Portugal, has arrived at the conclusion that the marine fauna of the secondary rocks in Portugal bear a far greater resemblance to the corresponding faunæ of North-Eastern Europe than to that of South Europe.

M. Fotterle on the Brown Coal of Zorencedo (Nicentine).

This coal is embedded in the basaltic tuff of the Monti Beridi, overlying a small surface of the Eocene Tertiaries. Two coal-seams from three and a half to seven feet in thickness, are at present open; both contain well-preserved specimens of *Anthracotherium magnum*, Cuv., of which teeth or portions of jaws are in the possession of the Vienna Imperial Geological Institute.

Earthquakes and their connection with Meteorological Phenomena.

A letter addressed from M. Julius Schmidt, astronomer at the observatory, at Athens, to Director Haidinger, gives details of an earthquake felt there on July 4th, 1860, at half-past six p.m.. At the same time a violent thunderstorm was rising above Mount Hymettus, and low clouds of a quite uncommon form began to cover the top of the mountains. M. Jul. Schmidt has stated the coincidence between atmospheric phenomena and subterraneous commotions of a probably local nature being circumscribed within the geological system of Mount Hymettus. The observations of this able astronomer have given the following results:

1852. July 16th, evening: commotion; strong thunderstorm on Mount Hymettus; abundant rain; clouds of striking form on the mountains.

1860. Feb. 6th, morning: commotion; thunder-stroke on Mount Hymettus; clouds of uncommon form on this mountain, persisting during half an hour.

1860. July 4th, evening: commotion; violent thunderstorm on Mount Hymettus; clouds of fantastic forms.

At the date of this letter (July 7th) M. Schmidt was specially employed in observing the new comet. During May 1860 he joined Prof. Unger of Vienna in a tour through Eubœa (where he measured Mount Delph, or Diphis, one thousand seven hundred metres in height, or about five thousand four hundred feet, Bœotia, and back to Athens through Eleusis. Interesting facts concerning the topography and hydrography of Bœotia were the result of this excursion. On July 9th M. Schmidt was to set out for Egina for two days. The Greek government has directed the provincial authorities to collect evidences concerning earthquakes, and to transmit them to the observatory at Athens.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—*December* 5, 1860.

"On the Structure of the North-west Highlands, and the relations of the Gneiss, Red Sandstone, and Quartzite of Sutherland and Ross-shire." By Professor James Nicol, F.G.S.

The author first referred to his paper in the Quart. Journ. Geol. Soc., vol. xiii., pp. 17, &c.. in which the order of the red sandstone on gneiss, and of quartzite and limestone on the sandstone was described, and in which the relation of the eastern gneiss or mica-schist to the quartzite was stated to be somewhat obscure on account of the presence of intrusive rocks and other marks of disturbance. Having examined the country four times, with the view of settling some of the doubtful points in the sections, the author now offered the matured results of his observations. He agrees with Sir R. Murchison as far as the succession of the western gneiss, red sandstone, quartzites, (quartzite and fucoid bed), and limestone is concerned; but differs from him in maintaining that there is no upper series of an "upward conformable succession" from the quartzite and limestone into the eastern mica-slate or gneiss—the so-called "upper gneiss." The "upper quartzite" and "upper limestone" the author believes to be portions of the quartzite of the country, in some cases separated by anticlines and faults and cropping out in the higher ground, and in other instances inverted beds with the gneiss brought up by a contiguous fault and overhanging them. The latter condition of the strata, as well as other cases where the eastern gneiss is brought up against the quartzite series, have, according to the author, given rise to the supposed "upward conformable succession" above referred to. In some cases where "gneiss" is said to have been observed overlying the quartzite, Professor Nicol has determined that the overlying rock is granulite or other irruptive rock, not gneiss.

The sections described by the author in support of his views of the eastern gneiss not overlying the quartzite and limestone, but being the same as the gneiss of the western coast, and brought up by a powerful fault along a nearly north and south line passing from White Head (Loch Erriboll) to Loch Carron and the Sound of Sleat, are chiefly those which had been brought forward as affording the proofs on which the opposite hypothesis is founded; and in all, the author finds irruptions of igneous rocks, and other indications of faults and disturbance, depriving them, in his opinion, of all weight as evidence of a regular order of "upward and conformable succession."

Prof. Nichol further argues that the mode of the distribution of the rocks shows that there is through Sutherland and Ross-shire a real fault, and no overlap of eastern gneiss of more than a few feet or yards at most; and that the fact of different strata of the quartzite series being brought against the gneiss at different places supports this view, and points to a great denudation having taken place along the line of fault. Though the quartzite is here and there altered by the igneous rocks, yet it is truly a sedimentary rock, and so is the limestone; but the eastern gneiss or mica-schist is a crystalline rock throughout. This fact, according to the author, is inimical to the hypothesis of the eastern gneiss overlying the limestone and quartzite. It has been insisted upon, that the strike of the western gneiss is different from that of the east; but the author remarks that the strike is not persistent in either area, and that the great movements subsequent to the deposition of the quartzite series have irregularly affected the whole region. With regard to mineralogical characters, Professor Nichol insists that both the eastern and western gneiss are essentially the same. Both are locally modified with granitic and hornblendic matter near igneous foci: but no proof of difference of age in the two can be obtained therefrom. The alteration in bulk of the gneiss in the western area, by the intrusion of vast quantities of granite now observable in it, may perhaps have caused the great amount of crumpling and faulting along the north and south line of fault, dividing the western from the eastern gneiss,—a fault comparable with and and parallel to that running from the Moray Frith to the Linhe Loch, and to the one passing along the south side of the Grampians.

December 19, 1860.—1. "On the Geological Structure of the South-west Highlands of Scotland." By T. F. Jamieson, Esq.

In this paper the author attempts to throw light on the relations of those rocks which figure in geological maps as the mica-schist, clay-slate, the chlorite-slates, and the quartz-rock of the south-western Highlands, which range north-east through the middle of Scotland, forming an important feature in the geology of that country. An examination of these rocks, as displayed in Bute and Argyleshire, has led Mr. Jamieson to believe that, from the quartz-rock of

Jura to the Old Red Sandstone, there is a conformable series of strata, which, although closely linked together, may be classed into three distinct groups, namely, 1st, a set of lower grits (or quartz-rock), many thousand feet thick; 2ndly, a great mass of thin-bedded slates, two thousand feet or more thick; and 3rdly, a set of upper grits, with intercalated seams of slate of equal thickness. Beds of limestone occur here and there sparingly in all the three divisions; the thickest being deep down in the lower grits. All the limestones are thickest towards the west. The siliceous grits also appear to be freer from an admixture of green materials towards the west. All the members of the series (namely, the upper grits, slates, and lower grits) have a persistent south-west to north-east strike, sometimes in Bute approaching to due north and south. They are conformable, and graduate one into another in such a way as to show that they belong to one continuous succession of deposits. The materials of which they have been formed seem to have been derived from very similar sources. The upper and lower grits are very similar in composition, being made up of water-worn grains of quartz, many of which are of a peculiar semitransparent bluish tint.

The rocks of the district have been thrown into a great undulation, with an anticlinal axis extending from the north of Cantyre through Cowal by the head of Loch Ridun on to Loch Eck (and probably by the head of Loch Lomond on to the valley of the Tay, at Aberfeldy), and with a synclinal trough lying near the parallel of Loch Swen. The anticlinal fold is well seen in the hill called Ben-y-happel, near the Tighnabruich quay in the Kyles of Bute. Southward of this ridge, which is composed of the lower grits or quartzite, the thin-bedded greenish slates and the upper grits succeed conformably; and the latter are separated by a trap-dyke from the Old Red Sandstone of Rothsay. This section the author described in detail; also the corresponding section to the north of the anticlinal axis, towards Loch Fyne, and along the west shore of Loch Fyne. The lower grits extend as far as Loch Gilp, and are then succeeded by the green slates and the upper grits, which falling in the synclinal trough are repeated through Knapdale towards Jura Sound, where the green slates again form the surface along the eastern coast of Jura, lying on the quartzite or grits of that island. Throughout the synclinal trough and the neighbouring district (that is, from Loch Fyne to Jura Sound) the grits and slates are intimately mixed, with numerous intercalated beds of greenstone, some being of great thickness. Mr. Jamieson pointed out that this feature of the district has hitherto in great part been misunderstood, and that Macculloch was in error when he denominated these rocks "chlorite-schist."

The probable relationship of the rocks of the Islands of Shuna, Luing, and Scarba to those of Jura and Bute were then dwelt upon; the greenstones of Knapdale, &c., and their relation to the sedimentary rocks, were described in detail; and the limestones of the district briefly noticed. As no fossils have hitherto been found; palæontological evidence of the age of these rocks is wanting; but the author, regarding their general resemblance to the quartz-rocks, limestones, and mica-schists of Sutherlandshire, thinks them to be of the same date as those rocks of the north-west Highlands.

2. "On the position of the beds of the Old Red Sandstone in the Counties of Forfar and Kincardine, Scotland." By the Rev. Hugh Mitchell. Communicated by the Secretary.

In Forfar- and Kincardine-shire, south of the Grampians, the Old Red Sandstone is developed in the following series, with local modifications:—1st (at top) conglomerate; 2nd, grey flagstone with intercalated sandstone (about forty feet deep at Cauterland Den, one hundred and twenty feet at Carmylie); 3rd, gritty ferruginous sandstone, with occasional thin layers of purplish flagstone. Of the last, one hundred and twenty feet are seen at Cauterland Den;

it occurs also at Fery Den, &c. The flagstone of this third or lowest member of the group yields ripple-marks, rain-prints, worm-markings, and crustacean tracks (of several kinds, large and small). *Parka decipiens* has been found in the lowest grits; and *Cephalaspis* in the sandstone at Brechin, immediately under the grey flagstones.

In the second member, namely the grey flags, fish-remains have of late been found more or less abundantly throughout the district, together with crustacean fossils. *Cephalaspis Lyellii*, Ichthyodorulites, Acanthodian fishes, *Pterygotus*, *Eurypterus*, *Kampecaris Forfariensis*, *Stylonurus Powriensis*, *Parka decipiens*, and vegetable remains are the most characteristic fossils.

The author pointed out that some few genera of fish and crustaceans were present both in this zone and in the Upper Silurian formation, and that still fewer links existed to connect the fauna of the Forfarshire flags with the Old Red Sandstone north of the Grampians, with which it appears to have, in this respect, almost as little relation as with the Carboniferous system. With the Old Red of Herefordshire these flags appear to have some few fossils in common; but of about twenty *species* found in Forfarshire, only about four could be quoted from Herefordshire.

In conclusion, the author noticed the vast vertical development of the whole series, and its great geographical extent; and particularly dwelt upon the distinctness of the fauna of the flagstones of Forfarshire, as giving good grounds for the treatment of the Old Red fauna as peculiar to a separate geological period, both as distinct from the Silurian system, and in some degree as divisible into two or more members of one group:—three members, if the upper or Holoptychius-beds of Moray, Perth, and Fife, the middle or fish-beds of Cromarty and Caithness, and the lowest or Forfarshire beds be counted separately; but two, if we regard some of the Old Red beds north of the Grampians as equivalent in time to those on the south.

January 9, 1861.—1. "On the Distribution of the Corals in the Lias." By P. B. Brodie, M.A., F.G.S.

From observations made by himself and others, the author was enabled to give the following notes. In the Upper Lias some Corals of the genera *Thecocyathus* and *Trocoeyathus* occur. The Middle Lias of Northamptonshire and Somersetshire has yielded a few corals. The uppermost band of the Lower Lias, namely, the zone with *Ammonites raricostatus* and *Hippopodium ponderosum*, contains an undescribed coral at Cheltenham and Honeybourn in Gloucestershire; and a *Montlivaltia* in considerable abundance at Down Hatherly in Gloucestershire, at Fenny Compton and Aston Magna in Worcestershire, and at Kilsby Tunnel in Northamptonshire. The middle members of the Lower Lias appear to be destitute of corals. In the zone with *Ammonites Bucklandi*, called also the Lima beds, *Isastræa* occurs in Warwickshire and Somersetshire. Dr. Wright states that *Isastræa Murchisonii* occurs in the next lowest bed of the Lower Lias, namely the White Lias with *Ammonites planorbis*, at Street, in Somersetshire; and another coral has been found in the same zone in Warwickshire. Lastly, in the "Guinea-bed" at Binton in Warwickshire another coral has been met with.

The *Montlivaltia* of the Hippopodium bed and the *Isastræa* of the Lima-beds appear to have grown over much larger areas in the Liassic Sea than the other corals here referred to.

2. "On the Sections of the Malvern and Ledbury Tunnels, on the Worcester and Hereford Railway, and the intervening Line of Railroad." By the Rev. W. S. Symonds, M.A., F.G.S., and A. Lambert, Esq.,

In this paper the authors gave an account of the different strata exposed by the cuttings of the Worcester and Hereford Railway (illustrated by a carefully constructed section), including the different members of the New Red Sandstone (on the east of the Malvern hills), the syenite and greenstone (forming the nucleus of the Malverns), and the Upper Llandovery beds, the Woolhope shales, the Woolhope limestone, Wenlock shales, Wenlock limestone, and Lower Ludlow rock on the west side of the syenite, followed by some beds of the Old Red series, violently faulted against the Ludlow rock at the west end of the Malvern tunnel. Then the open railway passes over Upper Ludlow rocks and some lower beds of the Old Red series, here and there covered by drift, until the Lower Ludlow rock is again traversed at the east end of the Ledbury tunnel, and is shown to be much faulted and brought up against Upper Ludlow shales and Aymestry rocks. The Wenlock shales and the Wenlock limestones are then traversed; these are much faulted, the Lower Ludlow rocks again coming in, followed by Aymestry rock, Upper Ludlow shales, Downton sandstone, and, at the east end of the tunnel, by red and mottled marls, grey shales and grits, purple shales and sandstones, with the Auchenaspis-beds, forming the passage-beds into the Old Red Sandstone, as described in a former paper (Quart, Journ. Geol. Soc., vol. xvi., p. 193).

In a note, Mr. J. W. Salter, F.G.S., described the great abundance of Upper Silurian fossils found in these cuttings, and now chiefly in the collection of Dr. Grindrod and other geologists at Malvern and the neighbourhood.

January 23, 1861.

1. "On the Gravel Boulders of the Punjâb." By D. Smithe, Esq., F.G.S.

In the Phimgota Valley (a continuation of the great Kangra or Palum Valley) the drift consists of sand and shingle with boulders of gneiss, schist, porphyry, and trap, from six inches to five feet in diameter. Some of the boulders, having a red vitreous glance, occur in irregular beds. This moraine-like drift lies on the tertiary beds, which, here dipping gently towards the plains, gradually become vertical, and are succeeded by variegated compact sandstones, gradually inclining away from the plains; next come various slates at a high angle, and gneissic rocks lie immediately over them.

2. "On *Pteraspis Dunensis* (*Archæoteuthis Dunensis*, Roemer)." By Prof. T. H. Huxley, F.R.S. Sec. G.S.

The fossil referred to in this communication is from Daun in the Eifel, and was described by Dr. Ferd. Roemer (in the "Palæontographica," vol. iv. p. 72, pl. 13) as belonging to the naked Cephalopods, under the name of *Palæoteuthis Dunensis* (changed to *Archæoteuthis* in the 'Leth. Geogn.'); and in the Jahrb., 1858, p. 55, Dr. F. Roemer described a second specimen from Wassennach on the Leacher See. Prof. Huxley, reproduced. with remarks, Dr. Roemer's description of the specimens; and after observing that Mr. S. P. Woodward had already suggested (Manual of Mollusca, p. 417) that Roemer's fossil was a fish, he stated his conviction that it was really a *Pteraspis*, agreeing in all essential particulars with the British *Pteraspides*, though possibly of a different species.

3. "On the 'Chalk-rock' lying between the Lower and the Upper Chalk in Wilts, Berks, Oxon, Bucks, and Herts." By W. Whitaker, Esq., B.A., F.G.S.

The author has more particularly examined the band which he terms "Chalk-rock," on the northern side of the western part of the London basin. Here it has its greatest thickness (twelve feet or more), to the west, gradually thinning eastward. It is a hard chalk, dividing into blocks by joints perpendicular to the bedding; and it contains hard calcareo-phosphatic nodules. It contains no flints, and in the district referred to none occur below it, whilst there is often a bed of them resting on its upper surface. It seems to form an exact boundary between the upper and the lower chalk, being probably the topmost bed of the latter. In this case it will often serve as an index of the relative thickness of these divisions, or as a datum for the measurement of the extent of the denudation of the upper chalk.

North of Marlborough, where it is thick, the chalk-rock appears to have given rise to two escarpments (an upper and lower one), in the chalk range.

Fossils are usually rare in this bed; but Mr. J. Evans, F.G.S., collected several from it near Boxmoor; and amongst them is the genus *Belosepia* (hitherto known only as tertiary); *Baculitus*, *Nautilus*, *Turrilites*, *Solarium*, *Inoceramus*, *Parasmilia*, and *Ventriculites* are here represented; and the following species have been identified—*Litorina monilifera* and a new species, *Pleurotomaria*, sp. *Myacites mandibula*, *Spondylus latus*, *Sp. spinosus*, *Rhynchonella Mantelliana*, *Terebratulata biplicata*, and *T. semiglobosa*.

The fossils mostly have a lower-chalk character. Two species, *Littorina monilifera*, and *Myacites mandibula*, have not been noticed in England above the Upper Greensand.

February 6, 1861.

"On the Altered Rocks of the Western and Central Highlands." By Sir R. I. Murchison, F.R.S., V.P.G.S., and A. Geikie, Esq., F.G.S.

In the introduction it was shown that the object or this paper was to prove that the classification which had been previously established by one of the authors in the county of Sutherland was applicable, as he had inferred, to the whole of the Scottish Highlands. The structure of the country from the borders of Sutherland down to the western part of Ross-shire was detailed, and illustrated by a large map of Scotland coloured according to the new classication, and by numerous sections. Everywhere throughout this tract it could be proved that an older gneiss, which the authors called "Laurentian," was overlaid unconformably by red Cambrian sandstones; these again unconformab'y by quartz-rocks, limestones, and a gneissose and schistose series of strata, as previously shown in the typical district of Assynt. From the base of these quartz-rocks a perfect conformable sequence was shown to exist upwards into the gneissose rocks, which is not obliterated by granite or any similar rock.

The tract between the Atlantic and the Great Glen consists, according to the authors, of a series of convoluted folds of the upper gneissose rocks, until, along the line of the Great Glen, the underlying quartzose series is brought up on an anticlinal axis. A prolongation of this axis probably exists along part of the west coast of Islay and Jura, two islands which exhibit a grand development of the lower or quartzose portion of the altered Silurian rocks of the Highlands.

From the line of the Great Glen north-eastward to the Highland border, the country was explained as consisting of a great series of anticlinal and synclinal curves, whereby the same series of altered rocks which occur on the north-west is repeated upon itself. One synclinal runs in a north-east and south-west direction across Loch Leven. The anticlinal of quartzose rocks that rises from under it to the south-east spreads over the Bredalbane Forest to the Glen Lyon Mountains, where it sinks below the upper gneissose strata with their associated limestones. Ben Lawers occupies the synclinal formed by these upper strata, and the limestones and quartz rock come up again in another anticlinal axis corresponding with the direction of Loch Tay. The continuity of these lines of axis was traced both to the north-east and south-west.

It thus appeared that the crystalline rocks of the Highlands are capable of reduction to order; that the same folds and curves could be traced in them as in their less altered equivalents of the South of Scotland; and that in what had hitherto appeared as little less than a hopeless chaos, there reigned a regular and beautiful simplicity.

In conclusion, Sir Roderick Murchison vindicated the accuracy of his published sections in the north-west of Sutherland, which had been approved after personal inspection by Professors Ramsay and Harkness; and he gave detailed reasons for disbelieving the accuracy of the sections recently put forth by Prof. Nichol, which were intended as corrections of his own. He concluded by affirming, that, through the aid of Mr. Geikie, the proofs of the truthfulness of his own sections, showing a conformable ascending order from the quartz-rocks and limestones into crystalline and micaceous rocks, had now been extended over such large areas that there could no longer be any misgivings on the subject.

February 15, 1861. — *Annual General Meeting.* Leonard Horner, Esq., President, in the Chair.

The Secretary read the Reports, and the Society both as to numbers and finances was stated to be highly satisfactory.

The President announced the award of the Wollaston Gold Medal to Professor Dr. H. G. Bronn, of Heidelberg, Foreign Member of the Society, for his long and successful labours in aiding the progress of geological science in general, and more particularly for the assistance he has afforded to the progress of Palæontology, as evinced in his "Index Palæontologicus," and especially in his work "On the Laws of the Development of the Organic World." The President then announced the award of the Wollaston Donation Fund to M. Daubrée, of Strasburg, to aid in the progress of synthetic experiments similar to those of which he had recently given an account, and which he had intimated his intention of continuing, with the object of throwing light upon metamorphic action.

The President then proceeded to read his Anniversary Address, and commenced with biographical notices of some of the lately deceased Fellows of the Society, particularly the Rev. Baden Powell, Dr. G. Buist, Lieut.-Gen. Sir H. E. Banbury, P. J. Martin, Esq., Sir C. Fellows, Prof. J. F. L. Hausmann, &c.

The Ballot for the Council and Officers was taken, and the President, Leonard Horner, Esq., F.R.S.L. and E., was re-elected.

February 20, 1861.

1. "On the Coincidence between Stratification and Foliation in the Crystalline Rocks of the Highlands." By Sir R. I. Murchison, V.P.G.S., and A. Geikie, Esq., F.G.S.

Allusion was, in the first place, made to the early opinions of Hutton and Macculloch, who regarded the gneissic and schistose rocks of the Highlands as stratified. Mr. Darwin's view of the nature of the "foliation" of gneiss and schist were then referred to; and it was insisted that this condition was not to be found in the rocks of the Highlands; the so-called "foliation" which the late Mr. D. Sharpe had described in 1846 as characterizing the crystalline rocks of that country being, according to the authors, really mineralized stratification. It was then pointed out that, as Prof. Sedgwick had previously insisted on the wide difference between "foliated" or "schistose" and "cleaved" or "slaty" rocks, and as Prof. Ramsay had in 1848 recognised interlaminated quartz as being parallel to stratification in the Isle of Arran, "foliation" should be regarded as coincident with stratification, and not with cleavage in the Scottish Highlands.

After some observations on the occurrence of cleavage in slates at Dunkeld, Easdale, Ballahulish, and near the Spittal of Glenshee, the authors stated their belief that all the "foliation" of the crystalline rocks of the Highlands is nothing more than lamination due to the sedimentary origin of deposits, in which sand, clay, lime, mica, &c., have subsequently been more or less altered, and that the "arches of foliation" described by Mr. D. Sharpe (Phil. Trans. 1852) correspond in a general way with the parallel anticlinal axes shown by the authors in a former paper to exist in the Highlands. They remarked, that the synclinal troughs, however, are not expressed in Mr. Sharpe's figures, and that he has omitted the bands of limestone which they refer to as an important evidence of the stratification of the district. They also pointed out the acknowledged difficulty which the quartzites presented to Mr. Sharpe, but which readilly fall into the system of undulated strata that they have described. One of the quartzites having yielded an Orthoceratite, and pebbles being present in one of the schists of Ben Lomond, these facts were adduced as further evidences of the real stratal condition of the schists and quartzites of the Highlands.

2. "On the Rocks of portions of the Highlands of Scotland South of the Caledonian Canal, and on their equivalents in the North of Ireland." By Professor R. Harkness, F.R.S., F.G.S.

The author having had the opportunity of examining the geology of the north-west of Scotland in the year 1859, and more especially the arrangement of rocks described by Sir R. Murchison as "fundamental gneiss, Cambrian grits, lower quartz-rock, limestones, upper quartz-rock, and overlying gneissose flags," applied the results of his observations during last summer to portions of the Highlands lying south of the Caledonian Canal, and to the North of Ireland. Developed over a large portion of these districts are masses of gneissose rock, of varying mineral nature, and sometimes putting on the aspect of a simple flaggy rock. Where these gneissose masses come in contact with plutonic masses, they exhibit that highly crystalline aspect which induced Macculloch and others of the Scotch geologists to regard them as occupying an extremely low position among the sedimentary series, and to apply them to the Wernian term "primitive." Many of Macculloch's descriptions, however, show that this assumed low position is not the true place of this gneiss among the sedimentary rocks which make up the Highlands of Scotland.

In a section from the southern flank of the Grampians to Loch Earn (and in other directions from Loch Earn to Loch Tay, from Dunkeld to Blair Athol, in the Ben y Goe Mountains, in Glen Shee, &c.), there is seen a sequence which indicates that this gneiss is the highest portion of the series of rocks, with underlying quartz-rock and limestone.

In the county of Donegal, Ireland, a like sequence is seen. A section from Inishowen Head to Malin Head, along the east side of Loch Foyle, presents us with gneissose rocks above limestone and quartz-rocks, exactly as in Scotland. In no portion of Scotland south of the Caledonian Canal, nor in the North of Ireland, did the author recognise any traces of the "fundamental gneiss."

Geologists' Association.—On January 7th the members of this Society met at their rooms, 5, Cavendish Square, to receive the annual general report of the committee, and to elect the council and officers for the ensuing session. The report dwelt upon the continued success and prosperity of the Association, and stated the legacy left by the late Mr. Brown, of Stanway, had been funded; that members desirous of exchanging fossils had been placed in communication with each other; that a number of good geological books would be purchased, towards the formation of a library; that the collection of fossils in the Society's cabinet was increasing; and that, as the excursions to Folkestone, Maidstone, and Charlton during the past year had afforded great satisfaction to the members, it was intended to follow the same course during the coming summer, and hold two or three similar field lectures, of which timely notice would be given.

Papers were read the same evening "On the Geology of the Isle of Sheppey," by the Rev. R. Bingham. The author, speaking of the divisions of the Tertiary beds, alluded to the island of Sheppey being an outlier of the strata forming "the London Basin." He then proceeded to dwell upon the physical aspect of the locality; and gave much interesting information in reference to the cliffs and their fossil contents, stating that a ramble along the northern side would be rewarded with many a fossilized shell, fruit, and crustacean—silent witnesses of the existence of a group of spice-islands in that neighbourhood in ages long antecedent to the historic period.

2. "On Discoveries in the Lower London Tertiaries at Dulwich and Peck-

ham during the excavation for the Effra branch of the Great South High Level Sewer." By C. Rickman, Esq.

Various details connected with the open cutting running through Peckham Rye to New Cross, and the tunnel at Dulwich, having been given, attention was drawn to the remains of leaves, of shells (several of which have been figured and described in the last volume of this magazine, page 210), bones, and insect wing-cases, which have been found in soft and indurated clay by Mr. Evans (see page 39, vol. iv.) during the progress of the work. Twenty-one species of shells, it was mentioned, had been discovered at Peckham, and nineteen at Dulwich.

Archæological and Ethnological Societies—On the 19th of February a very important joint meeting took place in the rooms of the latter society, in St. Martin's Place, Trafalgar Square. We lay stress in this case on the term important, because this is the first instance of a joint meeting of any of the learned societies for the express purpose of discussing a particular subject:—the result was an entire success.

The flint-implements from the drift have attracted the earnest attention both of geologists and antiquaries, and on this occasion Mr. Thos. Wright, F.S.A., who was, we believe, the promoter of the joint-meeting, opened the discussion by an oral description of the collections exhibited, and gave a general account of the history and uses of stone implements by ancient and modern peoples, concluding by recanting his former opinions as to the natural character of these fossil implements, and admitting his subsequent conviction that they were really of human manufacture. Amongst the collections exhibited were that which M. Boucher de Perthes presented in 1847, the year previous to the publication of his "Antiquités Celtiques," to the Ethnological Society, and those of Mr. Evans, of Hemel Hempstead, the Rev. Mr. King, of Hoxne, Dr. Hunt, of Hastings, Mr. Edward Tindall, of Bridlington, &c.

Mr. Evans described the condition of the strata of Abbeville, Amiens, St. Acheul, &c., and stated the occurrence of *Cyrenæ* in the implement-bearing and mammaliferous drifts of the valley of the Somme.

Sir Roderick Murchison exhibited specimens found on the beach near Herne Bay, and supposed to have falled from the gravels on the surface of the London clay and Tertiary beds there.

The Rev. Mr. King described the deposits at Hoxne, and stated that a mammaliferous stratum occurred in the bottom of the valley of the Waveney, which must have been deposited subsequent to the excavation of the valley of the river.

Mr. Pengelly made such very important remarks on the Brixham cavern that we give his speech in full.

Mr. Pengelly said that there were reasons before the conclusive evidence obtained from the Brixham cavern, in 1858, for concluding that relics of man were associated with those of the fossil mammals. Such had been the case in Kent's Cavern, near Torquay, and from circumstances which had been met with there, it was argued that man was contemporaneous with those great beasts. One hitch, however, existed in the bare possibility that the collection was not original; but in 1858 a circumstance arose which has caused much light to be thrown on the question. In the November of the preceding year, a person residing at Brixham purchased the freehold of a small portion of a limestone hill immediately adjacent to the town, his intention being to work it as a quarry and ultimately to erect a few cottages on the excavated site. In January, 1858, the quarrying disclosed, in a north and south line of fracture, a hole large enough to admit of a man's hand. On one occasion when the workmen returned from their meals a crowbar which had been left was missing, and was supposed to have been stolen; but in the course of a few days, as the excavation proceeded, the size of the hole referred to had increased to such dimensions as to permit a small man to wriggle through. Drawn by curiosity to the spot, the workmen saw their missing crowbar on a ledge below, it having been probably thrust down through the hole in their absence by some one fond of a practical joke. The proprietor of the ground at once descended to recover his lost property, and found himself in a cavern. This cave, closed to external access as it had been, was free from the objections of the probable introduction and commingling, at subsequent periods, of human relics, which had been formerly urged against Kent's Cavern. When the cavern was first entered it consisted of two galleries, one nearly due north and south (magnetic), and the other nearly east and west; the first having an horizontal external opening at its northern extremity, but which was completely closed with fragments of the adjacent limestone firmly cemented with stalagmitic matter into a breccia. After this passage was forced Mr. Pengelly entered, and saw at the southern end of the north and south gallery, *on* the stalagmite floor the antlers of a reindeer. As this appeared a virgin cavern, it seemed exactly adapted to afford the evidence required to substantiate the position Kent's and other similar caverns had, from their open state, failed to do. Accordingly, Dr. Falconer—who had visited it—induced the Geological Society to take a lease of the cavern, and the Royal Society supplied funds for its excavation. The layers of deposit were carefully removed one by one. In the stalagmite there was found a fine bone of *Ursus spelæus*: below this was the "bone bed," with every bone and stone placed with their longest axes regularly in the plane of the bedding, and the shortest at right angles to it, except at one spot where they were found sticking in the mud, inclined in every direction, just as they had fallen in from above. Bones of animals, with flint-flake implements — some of the latter of a well-marked character, and unquestionably human relics—were found at the base of the "bone bed," having a depth of deposit over them varying from thirteen inches to as many feet. Mr. Pengelly kept, as the work proceeded, a minute journal of the exact position of every bone and implement in the cavern. The bones and implements found were cleared carefully out of the matrix with a knife; but, in one instance, within the space of about two square feet, there appeared to be a great number of bones together, and the whole mass was removed to Mr. Pengelly's house; and on being there subsequently cleaned by Dr. Falconer, in the presence of witnesses, proved to be the entire left hind leg of a cave-bear, fleeced, and having every bone in its true anatomical position, even the patella (knee-cap), and astragalus *in situ*; thereby showing that the fossil had not been washed out of some older deposit, and afterwards deposited in the cavern with relatively much more modern things, as flint knives, but that the ligaments of the leg were still in existence when it entered the cavern, that is, that man was contemporary with the Cave bear.

There was a remarkable circumstance connected with some well-rolled and worn nodules of brown hæmatite iron mingled with the flints and bones. The greater part of the town of Brixham stands in a valley running nearly east and west, and about three hundred feet wide at bottom. The hill on the north rises from the bottom at an angle of twenty degrees, and reaches the height of one hundred and thirty feet; this hill separates Brixham valley from Torbay, and near its summit, on the northern or Torbay side, there is a large mass or deposit of brown hæmatite iron, whence the nodules found in the cave were derived. The southern hill, known as Windmill Hill, rises from the valley at an angle of twenty-eight degrees, and reaches the same height as the former. The cavern is situated in the northern, or Brixham side of this hill, ninety feet above the sea, and seventy-five feet above the bottom of the valley immediately below; therefore, if the valley was at the time of the deposit of these bones, flint-implements, and nodules, as deep as it is now, the hæmatite nodules must have crossed the valley at right angles to its length, first descending a slope of twenty degrees, and then ascending another of twenty-eight degrees, a gradient of nearly one in two, before they could have entered the cavern. Hence it appears certain either that the valley could not then have existed, or that it had been filled up with gravel which had since been cleared out. In either case the bones and flint-implements would be of such great antiquity as is consistent with the subsequent reduction by natural causes of the valley to its present physical configuration.

Mr. Atkinson, the Asiatic traveller, in reply to some questions on the range of carnivorous animals stated that he had seen the Bengal tiger preying on the reindeer in its native districts.

Admiral Fitzroy gave an interesting description of the uses made by the Fuegians of stone weapons in killing the guanacos (the wild Llamas), with them, when these animals got their long legs entangled in the snow drifts—the stones being fastened by thongs of sinew in a split stick, and the weapons thus formed used like a butcher's pole-axe.

Mr. Blagg, who had found stone-arrow-heads in Battersea fields, thought they might have been in remote times flooded, and that the arrows and sling-stones might have been projected from the shore at birds and other objects of chase, and thus have become embedded in the mud of the lakes.

The reply of Mr. Wright, and some remarks from the president, Mr. Botfield, M.P., terminated a meeting of the liveliest and most interesting character.

The Glasgow Geological Exhibition.—The Society's exhibition of rocks, minerals, metals, and fossils was held, as proposed, in the Merchant's Hall, in December last. It was a great success, and gave much satisfaction to the lovers of geological science. Great praise is due to the members of the Society for the manner in which they got up this geological exhibition of plant and animal life that flourished on our globe long ages past. Every formation, from the earliest of the metamorphic rocks to the tertiary strata, was represented. The collection was divided into sections—classified according to their formations; the flora and fauna arranged in the natural order of succession, with printed cards, giving the names, and position of the strata in which they were found. The Scotch palæontologists must have been much gratified to see so fine and numerous a collection of fossils collected by the members resident in Glasgow and its neighbourhood. The limestones and shales of the Coal formation must have been well explored to give such rich and varied collections as those of Messrs. Young, Thompson, Armstrong, Crosskey, Johnston, and others. The numerous drawers were filled with thousands of specimens, arranged in order, and probably such a collection has never been exhibited by any society of a similar character.

The fossils of the Silurian and Old Red Sandstone formations consisted of specimens of Graptolites, Trilobites, shells, and fish-remains, principally from Scottish strata. There were some fourteen species of Graptolites (exhibited by Mr. Steven) one species of which had been hitherto unknown in Scotland: these early records of fossil-life were one of the marked features of this interesting exhibition. Dr. Slimon, of Lesmahagow, exhibited some of his fine specimens of crustacea from the Upper Silurian beds of that district. A very fine large slab from the upper Old Red Sandstone of Dura Den was also exhibited, and from the number of fish-remains on its surface it excited great attention. The Carboniferous specimens, ranging from the plants to the fishes, were fine and numerous, being the joint produce of several valuable private collections, and occupying the whole of two or three tables, some seventy feet in length. In these collections were many rare specimens from the coal-fields of the west of Scotland, several of them being new to Scottish strata, and one or two altogether so to science.

There were some fine Permian specimens which have only recently been discovered, showing the relation of the Permian with the Carboniferous fauna. A fine group of *Gryphæa incurva*, and some very fine specimens of English and Scotch Liassic fossils were exhibited by Mr. J. P. Fraser, late president of the Society. There were some rare specimens from the Oolite exhibited by the same gentleman; and a fine cast of the humerus of the *Pelorosaurus Conybearii* (taken by Dr. Mantell), the original of which is in the British Museum, was exhibited by one of the council, the Rev. H. W. Crosskey.

In the Cretaceous division there were exhibited some fine specimens from the chalk of England, embracing a good set of sponges, fish-remains, shells, palatal teeth of sharks; and some rare specimens from the chalk of the north-east of Scotland.

A series of Tertiary shells from the Paris basin. The various divisions of the Tertiary formation were represented. One collection of post-Pleistocene shells from the Kyles of Bute, and one from Uddevalla, in Sweden, showing well the similarity between the beds. Recent shells and plants, illustrative of extinct fossil types, and a very fine set of recent and fossil forms of Brachiopoda.

The metals were well represented, especially iron-, lead-, and tin-ores, and some particularly fine hematites, etc.

The minerals and rock-specimens were also very varied, and from many different localities. In addition to the names already mentioned as exhibitors, we have to add those of Messrs. Struthers, Ralph Moore, Skipsey, Currie, Gregory, J. Horne, Goodall, Gibb, Mark Fryer, Stewart, Farie, etc., whose varied collections of minerals, metals, or fossils contributed greatly to the success of this exhibition.

There were in all some forty exhibitors, and amongst them a working miner, who had collected specimens while at work in the deep pits of Cambuslang, near Glasgow. To add to the interest of this working man's collection of Ferns, Calamites, and Sigillaria, spines and teeth of fishes, and shells, he had brought a map and section of the Lanarkshire coal-fields, upon which he had marked the particular strata or deposits where he had worked, and found his specimens—either in the Ell coal, or Main, Humph, Splint, or Mussel-band, etc. The exhibition, as a whole, spoke well for the great industry of many of the members in collecting the various organic remains of the west of Scotland. By bringing all their various collections together, and having them compared, they will be stimulated to yet greater exertions in working out more fully the geology of particular districts; so that we may safely assert that the Glasgow Exhibition, besides creating a great interest in our local geology, will be the means of doing much good in spreading a general knowledge of the "fossil forms" of past creations; and creating a desire for geological information amongst the members themselves.

Professor Rogers also sent some "flint implements" from the drift-gravel of Amiens, in France, which added to the interest of the exhibition.

Liverpool Geological Society. *January* 15, 1861.—The President, Henry Duckworth, Esq., F.G.S., etc., read a paper "On the Isle of Peirin in the Gulf of Cambay," and gave an account of his explorations there a few years ago. The fossils discovered by him were chiefly remains of Mastodon, Bos, Cervus, Leptorhynchus, a broad-snouted Crocodile, and part of the lower jaw of a young *Deinotherium Indicum*.

Mr Geo. S. Worthy read a paper "On the Geology of Aust Cliff, Gloucestershire," giving a description of the principal features of this most interesting section, which consists of a base of carboniferous limestone, succeeded unconformably by new red marls, in which a considerable quantity of gypsum is found, and also strontian. These marls are succeeded by a portion of the

Lower Lias formation. This latter portion is of great interest, on account of the numerous fossils contained in some of the thin beds of limestone, etc., found there; one of the lowest beds of the Lias in this section being a thin stratum of calcareous conglomerate, containing a very great abundance of reptilian bones, coprolites, and fish-remains, known as the "bone-bed."

February 12, 1861.—The President read his annual address. After reviewing the progress of the Society, and giving a sketch of the geology of Liverpool and the surrounding district, he proceeded to describe the leading geological and palæontological discoveries of the past year, dwelling more particularly on the very interesting facts elucidated in France by Messieurs Lartet, Gosse, De Vibraye, and De Verneuil in connection with that great scientific question of the day, "the geological age of man."

"On the Geology of the Arctic Regions." By David Walker, Esq., M.D., F.R.G.S.

This paper was the result of the author's observations during the voyage of the "Fox," in search of Sir John Franklin. He stated that on approaching the coast of South Greenland, the appearance of the mountains at once shows their igneous origin, being composed of granite, gneiss, and mica-schist, with occasional intervals of quartzose rock. After proceeding along a coast-line of five hundred miles, the volcanic rocks appear. These are first seen at Disco Island, and continue with a few interruptions as far north as the expedition reached. The precise formation of the land between Jones' Sound and Lancaster Sound is not known, but from its tabular appearance it is most likely Upper Silurian Limestone, as occurs further westward in Barrow Strait.

To the southward of Lancaster Sound, Silurian Limestone appears as far as Possession Bay, when the primary and metamorphic rocks make their appearance. Beyond Croker's Bay, as far westward as visited, the formation is Upper Silurian Limestone; the hills presenting tabulated fronts to the sea, with deep ravines intervening, rendering the hills cone-shaped. The shore of Barrow Strait is also made up of similar cone-shaped hills of Silurian Limestone. The west coast of Regent Inlet is of the same formation, but the fronts to seaward are much more elevated than on the north side of Barrow Strait. From Fury Point south to Bellot Strait the elevation of the land fronting the sea gradually decreases until it is seen lying against the granite, which forms a back-bone.

The author exhibited many specimens of the fossils he had collected from the Upper Silurian limestone described—Arctic species of the genera *Loxonema*, *Encrinurus*, *Spirifer*, *Atrypa*, *Rhynchonella*, etc. The resemblance of the specimens to those of Dudley and Colebrookdale is very remarkable. The presence of raised beaches and of Tertiary coal was also dilated upon.

Malvern Natural History Field Club.—The unfavourable weather of last year prevented the appointment of any Field Meeting earlier than the 15th of May, when a joint meeting of the Malvern and Worcester Clubs at Eastnor took place. The first move was to the line of the Worcester and Hereford Railway, striking it at the east end of the Ledbury tunnel, where a shaft had been sunk in the Ludlow rocks of the Silurian system, from the spoil banks of which Mr. Stephen Ballard, the engineer, explained the course to be taken by the line, while the geologists broke into the line with eager determination, but neither here or at an adjacent quarry of Aymestry limestone was any thing taken, except a stray *Lingula*. Since this time, however, the spoil has become much more productive.* The party moved on to the open cutting in front of the tunnel at May Hill, where the "Passage-beds," between the Silurian

* All the excavated material is to be sent down the shaft, and if well searched at that time will doubtless afford many valuable specimens.

deposits and the Old Red are finely displayed; and Mr. Symonds, F.G.S., the president of the Malvern Club, here delivered an oration on the position of the beds and their fossil contents.

Nowhere in the world was there, he thought, such a fine exhibition of "passage-beds" as here; and they incontestibly proved that there was a gradual transition from the Upper Ludlow Rocks of the Silurian system to the Old Red, and no sudden break with the entire destruction of organic life in the more ancient system, as had been formerly supposed. Mr. Symonds then remarked on the peculiar bucklered fish whose remains were embedded in the grey and red marls of this section, particularly the *Auchenaspis*; portions had also been detected of the *Plectodus*, *Cephalaspis*, *Pteraspis* and *Onchus*. These were all now extinct, and their only analogies were to be found in some of the rivers and lakes of North America.

Mr. Lees, the Vice-President, delivered the annual address, and took a review of the chief books on scientific subjects which had been published during the past year, remarking on the great tendency of the authors to theorise instead of, like Owen and Agassiz, carefully arguing only from undoubted facts. The former philosophical observer had declared that the result of his palæontological studies proved the continued exertion of creative energy from the earliest to the latest strata that had yielded their osseous remains to his view; but that all past races of animals belonged to the divisions now known to naturalists: nor was there any reason to believe that anything would be discovered that was different in general technical character to what naturalists were at present acquainted with.

Mr. Lees then took a searching review of Darwin's recent volume on "The the Origin of Species," and pointed out what he considered to be the fallacy of that writer's views, which he considered were merely a variation of the exploded theory of Lamarck, who had supposed the origin of every organic being in land and water from two nomadic forms. No practical benefit was gained by supposing that all existing species were varieties of what had pre-existed; and that minute variation now appearing and accumulating would in like manner, in a long period of time, change everything again.

In conclusion, Mr. Lees strongly urged the avoidance of all fanciful theory, and steadily keeping within the bounds of truthful observation. If they might not go so far as St. Piesse, as to say that he who had not studied nature knew not what real enjoyment was, yet they would fully agree with Humboldt that in the contemplation of her grandeur and freedom existed the purest delight that a divine intelligence had designed for the enjoyment of man.

At this meeting the Rev. R. R. Hill was elected Honorary Secretary of the Malvern Field Club, in the place of Mr. Burrow, who had filled the office since the formation of the club.

The next meeting was on September 21, at the Plough Inn, at Longdon. The members proceeded by Queenhill Church and through the grounds of Pale Court to Sandhill, a Lias outlier, in the valley of New Red Sandstone, which in this district stretches along the line of the Malvern straits. Hence the club returned through the Pale Court gardens, by permission of Mr. Dowderwell, to Mr. Stower at Chambers Court where Captain Guise delivered an instructive address. He was followed by Dr. Lankester, the well-known lecturer, on the Darwinian theory.

The third and last meeting was held at Malvern Hills, on October 9th. The President, and another gentleman, accompanied by Mr. Allan Lambert, one of the engineers on the Worcester and Hereford Railway went through the tunnel, but their account of the wet and dirt to be encountered deterred the other members from descending, a move was therefore made through the cutting of the Wych to the shaft on the western side of the hills, where large heaps of "spoil" had accumulated. Little, however, was found in them. The club then paid a visit to Mr. Stephen Ballard, at "The Winnings," who presented Mr. Symonds with some "old bones." They consisted of the humerus of *Bos primigenius*, from a lacustrine deposit on the western flank of the Malverns, together with a portion of the molar tooth of a mammoth, and a very perfect tooth and leg-bone of a rhinoceros from the Glacial drift, which skirts the eastern flanks of the Malvern range.

Afterwards the party proceeded along the line of railway, striking it just where the tunnel emerges into the open cutting. Here there occurs, just at the point of junction of the Old Red and the Silurian strata, curious mass of a bluish material so tough and leaden in its character as to have been almost impossible to excavate, resisting alike gunpowder and the pick. Hence the party followed the line to the bridge close by Barton Court, where a heap of Old Red has been curiously caught up in the midst of the Silurian.

The Winds' Point was the next object in view, where Mr. Symonds called the attention of the members to some large masses of Llandovery sandstone raised upon the flanks of the Syenite at the back of Mr. Johnson's house, and at least one thousand feet above the level of the sea.

After dinner, Dr. Grindson of Malvern, exhibited a beautiful series of fossils, most of which were obtained from the tunnel-shaft on the western side of the Malverns, and the quarries in the immediate neighbourhood of Ledbury. Amongst these and most worthy of notice was a magnificent Pentamerus slab from the tunnel-shaft at the Wych, a *Lingula Lewisii*, a *L. Symondsii*, a drawer containing many hundreds of trilobites—the eyes of many being particularly perfect, and several Bellerophons and other ancient fossils, many of them being new species, hitherto unknown aud unnamed, discovered by Dr. Grindrod.

NOTES AND QUERIES.

Pleistocene Fossils.—Dear Sir,—I have lately discovered in the Pleistocene clay of this neighbourhood (Salisbury), some teeth and several fragments of bones of a small rodent, apparently belonging to the genus *Arctomys* or *Spermophilus*. I much regret that I possess no recent skulls of either of these genera with which to compare the fossils. Under the head "Fossil Muridæ" in the Encyclopædia of Natural History, there is a mere nominal allusion to a species named by Professor Kaup *Spermophilus superciliosus*, from the Eppelsheim sand. Now I am well aware of the many calls upon your valuable time, but hope you will not deem me trespassing too much both upon it and your kindness in asking you to send me any information you may possess upon the following points:—1st. The specific character of *Spermophilus superciliosus*, with admeasurements of skull, and of any of the long bones. 2nd. Has this species been discovered in any part of Great Britain, or in any other continental locality besides Eppelsheim.

In event of my fossils proving a new species, I will, should you deem it worthy of publication, forward for a full description, with illustrations of the most perfect and characteristic bones.—Yours truly, H. P. Blackmore, M. D.

We would refer our correspondent to the following work:—"Descriptions d'ossemens fossiles de mammifères inconnus, jusquà présent, qui se trouvent au Museum grand-ducal de Darmstadt, 4to avec atlas in folio. By J. J. Kaup. Darmstadt 1832—1839.

References to works on fossil mammals of this order will be found at p. 236, vol. i, of Pictet's Traité de Paléontologie (Paris 1853—1857), where in plate vi., are figures of the teeth of the upper jaw of the *Arctomys alpinus*, the alpine marmot; and of the *Arctomys Arvernensis* from the Pliocene beds of Auvergne.

We learn from Pictet that remains of the *Arctomys arvernensis*, Brav., are also figured by Gervais, in his Zoologie et Paléontologie Français, pl. 26 and pl. 18.

The deposit in which Kaup found the Eppelsheim specimen was first regarded as Miocene, and since referred to the diluvium by H. von Meyer. It was a nearly complete specimen, surpassing the marmot in size. It is the *Arctomys primigenia* of Kaup, and *Myoxus primigenius* of H. von Meyer (Palæologica p. 61 and p. 109).

M. Gervais, in his Zool. et Pal. Français, p. 20, p. 46, figs. 11 and 12, refers to this species the bones found in the diluvium of Paris, Niort, and Issiore.

Arctomys spelæus, of Fischer von Waldheim (Nouveaux Mémoires de l'Academie de Moscow, 1834. t. iii, p. 381), has been found in the caverns of Prussia. It is allied in form to *A. bobac*, but its skull shows too many differences for the union of the species. M. Pomel in the Bulletin de la Société Géologique de France 2e serie, t. i, p. 591), indicates a marmot from the Auvergne alluvium differing from the *A. primigenia*.

The marmot of the alps (*A. marmotta*, Schreber) has been found a fossil in the diluvium of Mossbach and Koestrich. (Herm. v. Meyer, Neues Jahrb, 1847, p. 181).

The *Plesiarctomys Gervaisii*, Brav. et Pomel (*Notice sur les Ossemens Fossiles de la Débruge*: Gervais, *Zool. et Pal. Fr.*, p. 47), surpasses, slightly, in size the marmot, and has been found fossil in the lacustrine limestone of Saint Perréal, near Apt (Parisien supérieure).

The spermophils differ from the marmots in their pouches, and their lighter forms. They are found in the tertiary and diluvium beds. The *Spermophilus speciosus* of H. v. Meyer (Leonh. und Bronn, Neues Jahrb, 1846, p. 474) is only known by an upper jaw found at Weisenau, in miocene strata.

The *S. superciliosus*, Kaup (Oss. Foss. de Darmstadt, 5 liv., pl. 25, figs. 3—6), is found near Eppelsheim, with *Arctomys primigenia*. It is probably the same species as that from the bone-breccias of Montmorency, Auvers, and Auvergne. M. Desnoyers says that it is most nearly allied to *S. Richardsonii* of America (Bull. Soc. Géol. Fr., t. xiii.; Pomel, id., 2e série, t. iii., p. 212. Gervais: Zool. et Pal. Fr., p. 19).

Pictet places in this group the genus *Lithomys*, which H. v. Meyer established, Neues Jahrb., 1846, p. 175, for the miocene rodents of Weisenau, and which H. von Meyer in Bronn's "Enumerator" placed with the squirrels (*Sciurina*).

The marmots (*Arctomys*, Gmel.) have the lower incisors pointed like the squirrels, but less compressed, the molars "hérissées de pointes les formes lourdes," (Pictet) and the tail short. They have only been found in diluvium and upper tertiaries. The *Plesiarctomys* (Gervais) have the molars like those of the marmots, except that the tubercles are much more rounded, indicating a more frugivorous diet.

Errata in "Geol. of Cleveland."—At p. 82, line 16, for "analogies" read "*analysis*"—p. 83, line 1, for "portion" read "*position*"—p. 83, line 31, for "from the north part" read "*for the most part*"—p. 88, line 4, for clay-stones" read "*clay-ironstones*"—p. 90, line 30, for "east" read "*coast*"—p. 93, line 32, for "clay" read "*slag*"—p. 93, line 39, for "often" read "*just*."

Errata in "Geol. Excursion to the Channel Islands.—At p. 112, line 13 from the bottom, for "great" crystals read "*quartz*" crystals—p. 114, footnote, for "Mr Jukes" read "*Mr. Lukis*"—p. 115, quotation from Virgil, for "nudis" read "*nodis*."

FRAGMENT ON SUBMARINE ZONES OF DISTRIBUTION.—1. As soon as the main facts of the distribution of animals and plants into regions and districts, and into zones of elevation above the sea-level had been generally established, it was assumed that like limitations held good as to marine plants, and (as inseparable from them) to zoophytes.

2. It was thus laid down pretty positively that the coral animals could not exist at certain depths; and from these the inferences that coral formations, *per se*, could have no great thickness unless submerged whilst in progress by the sinking of the ground on which the animals had attached themselves as a nucleus or basis; and if this progress were carried on slowly the said animals, within "regulation limits" as to depth, could continue their work upwards as before.

2. In Darwin's valuable work on coral formations, p. 85, he gives certain tabulated data of the known depths at which corals have been found alive. The example most to my purpose (for I am unacquainted with "Cellepora" found at one hundred and ninety fathoms) is "Gorgonia, or an allied form," at one hundred and sixty fathoms deep.

4. The pressure at one hundred and sixty fathoms (taking sea-water at about sixty-five pounds per cubic foot) is four hundred and thirty-three pounds per square inch; and who that is at all familliar with the exquisite delicacy of structure in the polyp of gorgonia of any kind can suppose that mere internal counterpoise of water within to water without would render life possible in such types of all that is tiny, frail and fairy-like? No wood sunk to that depth would ever float on being drawn up to the surface: it would become "water-logged." Hence it is conceived that nothing but the mysterious agency of vitality can give the tissue its power of resisting the above mentioned and very considerable penetrative pressure. Who then is to limit the depth at which zoophyte life is to be found, and coral-reefs to be carried on?

5. Such being the case at one hundred and sixty fathoms, what are we to say to the facts given in Mr. G. E. Roberts' interesting paper—"High and Low Life"—in which the existence of Ophiocoma, &c., is traced to a depth of two miles, or eleven times the said one hundred and sixty fathoms?

6. It was ever to my mind an unproven verdict (or rather dictum) that laid down such strict analogy between the zones of distribution for terrestrial vegetation, and their assumed correspondents as regards marine plants and animals (especially the latter); as if they were the anamorphic reflections downwards of the terraced arrangement of zonal regions upwards, shown on the surface of the sea.

7. In earlier days I was once honoured with a slight, but "free and gentle" passage at arms—a sort of holme-fight—with one of our largest Oxodons, or Cantabnodons (we say not which), fresh from his native fens and reeds, who had taken post on this sandbank position, and in spite of every logical instinct on the *pourquoi non?* footing I presume, required me to prove a negative thereon. Strange to say, he was an eminent mathematician. What would he have said on seeing his sunderbund-hypothesis utterly dispersed by the facts of Dr. Wallich and Mr. Darwin?

8. It may be assumed, safely enough, that coral formations *may* spring from around any suitable nucleus in the very floor of the ocean; though not by any means restricted from starting their characteristic contours and belts from around the upper portions of submarine hills—working from thence upwards as from an advanced base of operation..—R. J. NELSON, R.E., Halifax, Nova Scotia.

SKELETON OF A NONDESCRIPT ANIMAL FOUND AT BUENOS AYRES.—(Vol. iv. p. 18).—I refer your correspondent who asks what scientific account has been given of the great animal preserved in the Madrid Museum, to Dr. Buckland's Esssay in the Bridgewater Treatise. The skeleton which is that of the Megatherium, is also described by Cuvier (Oss. Foss. vol. v., p. 142); and it may also be seen in Jameson's "Translation of Cuvier's Revolution of the Globe." The Madrid skeleton measured thirteen feet one inch in length, and is seven feet four inches in height to the top of the back. It has been several times figured. The finest series of plates illustrative of it are those of Pander and D'Alton.

The account given by the old traveller is amusing enough, but no naturalist could have been a moment in doubt as to the character of the animal, which belongs to the *Edentata* (root-eaters), very far removed from the Carnivores.

I append, for the amusement of those who like quaint zoological descriptions an extract from a Texas letter, relating the discovery of a great Pachyderm:—

"The great local excitement here just now is the fact that within the corporate limits of New Braunfals, within close pistol shot of the residence of our worthy mayor, the bones of an immense mammoth or mastodon have been discovered. I have not as yet visited the spot, or big hole in the ground, where the digging is going on, but am told that the specimens so far dug up promise a sizeable skeleton when all are put together,—say thirty odd feet long by twenty odd in height. Barnum might make a new start in the world were he now here to take advantage of this wonderful bringing to light of an undoubted curiosity.

"The discovery was first made by some German well-digger, who fell upon a huge shoulder-bone while prospecting underground for water. I will give more and fuller particulars when they excavete deep enough or wide enough to bring the entire "crittur" out, so that we can all see him, she, or it. If there ever was a spot upon earth where a huge animal could find a good range, it is right here, where the waters of the beautiful Guadalupe take in those of the more beautiful Comal." We should like to know more of this find.

But the most valuable book cf reference on the subject is the splendid "Memoir on the Megatherium or Giant Ground Sloth of America," by Prof. Owen, reprinted with additions from the Philosophical Transactions. A full description of the Madrid specimen, which was found "in some excavation on the banks of the river Luxan, which flows close by the town of the same name, about thirteen leagues west-south-west of Buenos Ayres, in a ravine ten yards in depth," is contained in a work of Don Joseph Garriga, entitled "Descripcion del Esqueleto de un Quadrúpedo muy corpulento y raro, &c. (Madrid, 1796). GEORGE E. ROBERTS.

NEW ZEALAND STEEL.—The following account of this remarkable deposit is given in the "Australian Mail:"—"Ever since the settlement of New Zealand by Europeans their attention has been daily called to the peculiarities of a kind of metallic sand along the shores of New Plymouth, in Taranaki.

"This sand has the appearance of fine steel filings, and if a magnet be dropped upon it and taken up again, the instrument will be found thickly coated with the iron granules. The place where the sand abounds is along the base of Mount Egmont, an extinct volcano; and the deposit extends several miles along the coast to the depth of many feet, and having a corresponding breadth.

"The geological supposition is that this granulated metal has been thrown out of the volcano along the base on which it rests into the sea, and there pulverised. It has been looked upon for a long time as a geological curiosity, even to the extent of trying to smelt some of it; but although so many years have passed since its discovery, it is only recently that any attempt has been made to turn it to a practical account in fact the quantity is so large that the people have looked upon it as utterly valueless. It forms a standing complaint in the letters of all the emigrants that when the sea-breeze was a little up they were obliged to wear veils to prevent being blinded by the fine sand which stretched for miles along the shore. Captain Morshead, a gentleman in the west of

England, was so much impressed with its value that he went to New Zealand to verify the reports made to him in this country, and was fortunate to find them all correct. He smelted the ore first in a crucible, and subsequently in a furnace. The results were so satisfactory that he immediately obtained the necessary grant of land from the government and returned to England with several tons, for more conclusive experiments. It has been carefully analysed in this country by several well-known metallurgists, and has been pronounced to be the purest ore at present known. It contains 88·45 of peroxide of iron; 11·43 of oxide of titanium, with silica, and only twelve of waste in one hundred parts. Taking the sand as it lies on the beach and smelting it the produce is sixty-one per cent of iron of the very finest quality; and again if this sand be subjected to what is called the cementration process, the result is a tough, first-class steel, which in its properties seem to surpass any other description of that metal at present known. The investigations of metallurgical science have found that if titanium is mixed with iron the character of the steel is materially improved; but titanium being a scarce ore, such a mixture is too expensive for ordinary purposes. Here, however, nature has stepped in and made free gifts of both metals on the largest scale. To give some idea of the fineness of this beautiful sand it will be enough to say that it passes readily through a gauze sieve of four thousand nine hundred holes or interstices to the square inch. As soon as it was turned into steel by Mr. Musket, Messrs. Mosely, the eminent cutlers and toolmakers of New Street, Covent Garden, were requested to see what could be done with the Taranaki steel. They have tested it in every possible way, and have tried its temper to the utmost, and they say the manner in which the metal has passed through their trials goes far beyond anything that they ever saw worked in steel before. It has been formed into razors, seizzors, saws, penknives, table-cutlery, surgical instruments, &c.; and the closeness of the grain, the fineness of polish, and keenness of edge place it in the very foremost rank—almost in the position of a new metal. As far as is at present known of this extraordinary metal, it bids fair to claim all the finer classes of cutlery and edge-tool instruments to itself so well has everything made from it turned out. Messrs. Moseley, in whose hands the sole manufacture of cutlery and edge-tools is vested for this country, have placed a case, filled with the metal in all its stages, in the Polytechnic Institution."

Description of the Rocks in which Diamonds are Found, and the manner of working them in the Province of Minas Garaes, in Brazil.—The granite-gneiss of which the shores of Brazil are composed extends without interruption as far as the Sierra of Montiguera, which is sixty leagues inland, at the point nearest the sea where it forms the boundary between the forest and the plains. In this last region one begins to see this gneiss alternate with granular quartz, and crystalline schists. Inland from the Serra of Ourobianco these last rocks dominate exclusively. To the north they also compose the numerous mountain ranges, and among them the "chapades," called by D'Eschwege the Serra D'Espinhaco.

Of the rocks which compose the Diamond region the granular quartz, which is the most important, has been called by D'Eschwege "itacolumite." It is a friable quartz or sandstone more or less coarse-grained, and often contains talc chlorite, and mica, and showing a schistose structure. It is sometimes traversed by veins of quartz containing pyrophylite-lime as found in the Ouralian mountains. Sometimes, though but rarely, is it flexible. We have noticed this quality at two places, Ouro-Preto and Montevade. This itacolumite is beyond doubt a metamorphosed rock, deposited in the first instance by water. No fossils have been found in it, but traces of wave-marks have been discovered. According to Mr. G. Rose, there is at Bissersk, in the Oural, where diamonds are found, no trace of this rock which however closely resembles the schistose granular quartz of the mountains near Strehlen to the west of Breslau, and which there underlies the quartz alternating with it and vast masses of white talcose schist, and is traversed by numerous veins formerly worked for clear quartz.

The schist which we have called "metamorphic" presents various characters; first of all it contains quartz associated sometimes with chlorite, or with talc; sometimes with mica: in the latter case it passes into mica-schist. It is not necessary to point out amphibole, hornblende, and schorl? among the varieties of this schist worked in searching for diamonds.

Sometimes it loses its schistlike nature, and then contains a quantity of oxide of iron. This schist constitutes generally speaking the elevated plains called "chapades." It rapidly decomposes as we shall see further on, and on this account the lower parts of the valley, into which the rivers proceeding from the chapades flow, are of an undulating nature, while their higher slopes are more or less precipitous.

The passages from metamorphic schist to clay-slate and schists containing talc, mica and cyanite are very frequent, and quite insensible. So on the other hand is the passage from the metamorphic schist to the itacolumite. Near the limit of these two rocks concretions and bands of specular iron-ore often occur. In the Serra de Caraça fragments of crystalline schist occur as a conglomerate in the itacolumite.

This metamorphic schist contains also limestone, schistose specular iron and itabirite, which is simply a variety of specular iron, accompanied by quartz and mica. It occurs in thick beds of great extent, which can be worked as ironstone. When this itabirite is found partially decomposed (pulvérulente), it goes under the name of "jacotinga." The valuable English mine of Gongosocco is worked in this jacotinga.

The limestone is well developed, and contains many caverns in which bones and saltpetre occurs. These have been studied by Dr. Lund.

The itacolumite and metamorphic schists occur generally in alternate beds. Their outcrop is parallel to the mountain-range, namely north and south, and they dip to the east. They have been disturbed in such a manner that they form rugged and abrupt rocks which in the itacolumite are traversed by a great many water-worn channels.

The schist and itacolumite decompose easily, the latter splitting and crumbling readily to dust, the former undergoing a chemical as well as a physical change in localities particularly rich in iron. The hydroxide of that metal when liberated goes to form, with the less decomposed fragments, a breccia, called "lapanhoacanga," a variety of which containing a greater quantity of sand is found in the valleys and rivers of the diamond region.

This decomposition sometimes reaches a great depth; the surface of the rock in the rainy season resembling a bog in which one sinks up to the knees.

It may be thought surprising that decomposition should go on to such an extent in the tropics, as it is not seconded by the action of frost, but it is doubtless hastened by the frequency of the tropical rains, and the dissolving action of the water increased by the temperature. It may also be observed that the tropical storms of frequent and regular occurrence charges the atmosphere with nitric acid, which is communicated to the water and increases its action.

It is in the product of the decomposition of these rocks, and in the recent lapanhoacanga that the diamond and numerous rare minerals occur. Among the latter we may mention topaz, chrysolite, amethyst, tourmaline, blue and black ore of titanium, transparent andalusite, euclase, and chrysoberyl.

Experience has taught the miners that diamonds are to be found in three distinct regions called Serviço da Serra, Serviço do campo, Serviço do rio.

In the first the rock worked for diamonds is a product of decomposition named "gurgulho," which presents different characters in the Serviço do Campo, and Serviço da Serra. In the former it is the product of itacolumite, formed of pure quartz sand, fragments of itacolumite and quartz. It fills the cavities resulting from the distruction of certain beds of itacolumite, which are called by the Brazilians canaes corrumes.

The method of washing is described by D'Eschwege, and with the diamond as residua are obtained rutiles, oxide of iron and oxide of titanium. These minerals which occur more or less with the diamond are named the "formation" (formaçao), and their presence in the gurgulho is considered as a sign that diamonds are not far off.

But on the Gurguhlo de Serra these minerals are to rare that it is impossible to recognize them without a previous washing, and even in certain beds they are almost entirely absent.

Of three minerals mentioned as constituting the formation in the itacolumite we have included rutile and oxide of iron; black tourmaline also, perhaps, should be mentioned, but no one has met with it.

As the minerals associated with the diamond are found in the itacolumite, it is natural to suppose that the diamond comes from the same source. The presence of diamonds in rivers rising in mountains of itacolumite is another evidence of this fact which Pohl and D'Eschwage had announced as probable, and Helmreicher has placed beyond doubt; for at the Serra Grao Mayor at Corgo dos Bois has proved that diamonds can not only be obtained from the washing of the gurgulho, but also from the fragments of a rock of itacolumite, which mode is not followed up because the washing process is easier and cheaper.

The Gurgulho do Campo is so called because it occurs in the plains and tablelands; it is formed by the decomposition of metamorphic schist of which the products are more or less mixed with itacolumite. The washing of the Gurgulho do Campo gives—firstly, blackish-grey grains and cyanite. Secondly, a bluish-black rock, sometimes ferruginous, sometimes quartzy, and allied according to M. Damour to schorl-rock. Thirdly, hydrophosphate of alluminum, hydroxyde of iron. Fourthly, hematite iron, red hematite, and perhaps titanic iron. All these substances are derived from the metamorphic schist. As to the quartz, rutile, amatase, sub-oxide of iron, they proceed equally from that and the itacolumite. The ensemble of the minerals associated with the diamond is called the "formation;" but here these are so abundant that it is often easy to distinguish them without a preliminary washing.

The Gurgulho do campo is met with on the surface, near the separation of the two great basins of the San Francisco, and of the Jequitnihouta, at Dattas, at Quinda, and at San Joao do Barro. As it does not appear to have been deposited by water one is forced to admit that it has been formed *in situ* by the decomposition of the underlying rock, sometimes, however, it has been water-borne some little distance.

As long as diamonds were found in the Gurgulho of the surface, they were not sought deeper; but about the year 1850 at San Joao do Barro the underlying schistose-rock was by chance submitted to the washing-process, when it was found to contain many diamonds. From this time a course of deep-mining has been pursued with the best results. The rock is so soft that it can be extracted by means of hoes: it is then thrown into the "cradle" and washed.

When the rock is examined *in situ* a schistose structure is perceived, which however has entirely disappeared in the gurgulho; the solid and heavy particles alone remaining.

The schisty rock found underlying the gurgulho is called "barro." It is of a very variable colour—white, reddish, dark grey or black. It is soft to the touch, and sometimes sand is obliged to be added to it to enable it to undergo the washing process. Between the gurgulho and this "barro" occur also various approximations to an earthy mass, which also contains diamonds, and which is designated "terra." The "barro" and "terra" are so decomposed and softened that the holes worked in the clay are filled in during the night. It is only in the dry season that the deep mines in the barro can be worked; the washing is carried on, on the contrary, in the rainy season.

The veined structure of the barro at once tells of its origin in the metamorphic schist, a fact confirmed by the following remarks. The schists lie nearly north and south and dip towards the east at an angle of thirty degrees. Besides underneath the "barro" a bed of granular itacolumite is met with called "Pizarro," it is easy to prove that this bed is intercalated in the schists and that its direction and dip are the same. On the other hand concretions are formed in its neighbourhood, as is the case at the termination of the metamorphic schist. Finally, the residue of the washing of the barro and the gurgulho do campo is exactly the same. We have, besides, examined the stony fragments which are found in the "barro," and have proved that they have been derived from the metamorphic schist in different stages of decomposition: some fragments were so unchanged that we could not for a moment doubt their origin.

It is very true that diamonds have not yet been found in the metamorphic schist, but that is easily understood as it has been so little worked. At the time that the barro is worked it is very soft and full of water: it hardens however on exposure. The diamonds it contains do not detach themselves at first, and in the washing we have been fortunate enough to obtain, at Diamantina, a specimen of barro which still contained a very large diamond: it also showed very clearly the origin of the rock. We have also seen a similar specimen belonging to Mr. T. Redington, who possesses diamond mines between San Joao and Diamantina.

Although there are many workings of the gurgulho at San Joao, that in the barro since 1855 has yielded richer and more regular products, and while we were there preparations were being made to open another. Near Quinda there are many workings of the gurgulho in which the underlying bed is also washed; but this bed has not the veined structure of that at San Joao, and is much more sandy. In this neighbourhood there is a sandy itacolumite, which cannot contain many diamonds, as it is never washed.

Observation has shown that the schists most rich in diamonds are strongly impregnated with oxide of iron, and that they have a grey or blackish colour. The Serviço do Rio comprises the searches made in the beds and on the banks of rivers. This mode of diamond hunting, more common than the other methods, is used to seek them when washed from their original situation. As it has been often described, we need not enlarge upon it; we have observed it in more than thirty localities from Cidade de Serro in almost all the water-courses on the road to Grao Mayor, especially at Poso Alto, Dattas, Quinda, Diamantina, Simao Viera. The principal workings of this nature occur on the Jequitinhonha. The rivers generally have their beds in the solid rock, in which, in some places, they have hollowed out immense cavities. The fluviatile deposit which rests on this rock, and in which they flow, is called "cascalho;" it is sometimes covered with large blocks, which evidently belong to the itacolumite. When the hydroxide of iron occurs in the neighbourhood, it has cemented the upper beds, and changed them into a conglomerate—the "Canga," which is sometimes so hard that it has to be blasted; in it diamonds are sometimes found enclosed, of which there are several specimens in Europe. The cascalho contains the products of the decomposition of the itacolumite and the metamorphic schist; the minerals which it contains are, therefore, those of the Serviço da Serra and Serviço do Campo; but they are more rolled and rounded, and sometimes the one and sometimes the other preponderates, consequently the characters of this conglomerate are very varied. In the museum at Rio Janeiro a fragment of pure quartz two or three inches in diameter contains two cavities, which are both filled with small fragments of quartz and oxide of iron, which are firmly cemented by a clayey cement; in one of the cavities a diamond is seen in the middle of the conglomerate. We have also been assured that near Diamantina diamonds have been found among the stones composing the little cylindrical tubes which certain wormlike insects of the mountains on the coast construct to protect themselves.

Another remarkable fact which has not been previously noticed, is the discovery in the cascalho of small fragments of quartz having a form like an anvil. They have clearly been polished, and have therefore been constructed by the Indians, who used them as earrings. At Grao Mayor, M. Daniel Casimer Pinto-Coelho gave us one of these; the cascalho in which it was found had never been worked or disturbed in any way, and formed the bed of a water-course nearly dried up; it was even covered over by more than six yards of vegetable mould, on which beautiful palm trees were growing. The polished quartz ornaments are accompanied by other cut objects, principally arrow-heads; bones also occur, of the nature of which we have not been able to pronounce.

These traces of human industry met with in the virgin cascalho prove it to be of comparatively recent origin, consequently also the red race must be very ancient. It is to be hoped that the researches of Dr. Lund on the bones found in the neighbouring caverns wlll throw some light upon this important question.

We will point out two or three more names in common use. The cascalho of the old water-courses is called "Gupiara;" that accumulated at the heads of the rivers "Tabuleira;" lastly "Corrido," is the name given to the half-rounded pebbles found in the present rivers.

Itacolumite and metamorphic schist are, beyond doubt, the beds in which the diamond and all other precious stones with which it is found originate. Nevertheless, these gems are not necessarily met with, any more than the green tourmaline of Campo Longa and the realgar of Brimenthal are seen in all the dolomites of the Alps. The diamond is found in the mountains of itacolumite of Grao Mayor, also in the numerous streams which flow therefrom; it exists equally in many other mountains of itacolumite, but it is too rare to be searched for with advantage. Thus, in the Serra do Cipo, in the basin of the San Francisco, we have seen four diamonds which have been found in a small stream near the upper part of this Serra. On the other hand, the mountains of itacolumite do not necessarily contain diamonds, and in that of Itacolumi, which gives its name to the rock, diamonds are not found. To the present time the metamorphic and decomposed schist of San Joao or of Quinda is the only one in which the diamond has been observed; but the large tract of the gurgulho do campo shows that this schist is very extensively spread, and it ought to contain diamonds in various localities.

The following are some remarks that we have made on the distribution and associations of the minerals which accompany the diamond.

The anatase is sometimes so pure and transparent that one is tempted to mistake it for the diamond. It is, besides, associated with the sub-oxide of iron, and with rutile as well as brookite.

The euclase is always found with the topaz, and in many places to the south of Ouro Preto it is in a kind of whitish clay, which seems a product of decomposition. There is also specular iron-ore and rutile, like that of Saint Gothard; beautiful black tourmalines, hyaline and smoky quartz. These minerals are found, too, in the barro of San Joao, so that the latter appears identical with the whitish clay met with in the working of the topaz. The euclase is much rarer than the topaz, and as they no longer search for the latter for jewellery, it is become impossible to procure it. At times the topaz is decomposed, and then it is known under the name of "rotten topaz."

The ores of tellurium are met with at Saint Jozé d'Elrei, and near Saint Vincent, between Ouro Preto and Morro Velho; moreover, there is some native brimstone in a vein of quartz near Saint Jozé.

The crystalline schists of Morro Velho and of Sabarra contain fine crystals of carbonate of lime, of arragonite, of magnetic iron-pyrites, of copper-pyrites, of manganese-ore; in those of Congonhas there is chromate of lead.

Arsenical pyrites are observed in the quartz at Ouro Preto, Morro Velho, and Antonio Pereira.

Scorodite, pseudomorphs of hemonite after the scorodite, and scorodite after arsenical iron, are found in the crystalline schist, and in the "tapanhoacanga" of Passagem and Antonio Pereira. The amethyst forms in veins in the crystalline schist and in the gneiss.

The chrysolite, cymophane, green and transparent tourmaline collect in the cascalho of the rivers which traverse the crystalline schist near Kalihao.

The American river and the Pianhy seem to be the richest; the first is no longer worked, but for twenty leagues along the road to Kalihao it seems to have been entirely excavated; it is in the river Pianhy that the chrysolite is found, which is employed in clock-making and in jewellery. The transparent andalusite is also brought from one of these two rivers. Among the various minerals that are found in the cascalho of Brazil, we can mention, as does also M. Damour, disthene, felspar, precious garnet, hydrophosphate of aluminum, phosphate of yttria, pure and titaniferous, diaspore columbite, Baierine, oxide of pewter, cinnabar, and graphite.

Gold is everywhere found in the region of the diamond-bearing schists, and there is also platinum; these metals remain upon the vatée with the other ores that the washing separates from the diamonds.—Translation of a Paper read before the Geological Society of Berlin. By MM. Ch. Heusser and G. Clarez, with mineralogical notes by G. Rose (Ann. des Mines, vol. xvii., part 2 of 1860.

SILURIAN STRATA, NEAR CARDIFF.—DEAR SIR,—In your January number there was a notice of "Murray's Handbook for South Wales." In the notice of places of geologic interest appended to that book there is an omission I should like to supply. A short time since I was residing at Cardiff, on the borders of Glamorganshire, and in my walks about the neighbourhood discovered a quarry in what seemed to me to be the Upper Silurian formation. This quarry is situated on a hill-side about two miles east of Cardiff, at a place called Pen-y-lan, and from the mouth of the quarry there is a beautiful view of the Bristol Channel and the opposite coast. Tracing the course of some brooks in the neighbourhood, I found the same kind of rock extended for some distance round the side of the hill. The quarry I found to be very full of fossils. Shells were in abundance. Amongst others I have a *Bellerophon dilatatus*, and an *Athyris tumida*, with the internal spiral processes in a beautiful state of preservation. Corals also were in abundance, though not so much so as shells and trilobites: of the latter I found perfect specimens of *Illænus Barriensis*, two kinds of *Acidaspis*, *Calymene Blumenbachii*, *Encrinurus punctatus*, *Phacops caudatus*, *Phacops (caudatus) Leryi*, and *Phacops Stokesii*, and a head and tail of *Cheirurus bimucronatus*.

I have also out of the same quarry a large head of *Phacops caudatus*, in one eye of which sixty two spherical lenses still remain. This specimen was presented to me by Mr. J. B Thomas, of Cardiff, who is the only local geologist.

Believing on the above evidence the rock in question to be Silurian, I was surprised to find it mapped in the Geological Ordnance Survey as Old Red Sandstone. I therefore communicated the fact to Sir Roderick Murchison, and at his request sent him my fossils, when after they had been examined by himself and Mr. Salter, he determined the rock from which they came to be "par excellence" of the Wenlock age.

Thinking that some of your readers when passing through South Wales might like to visit the spot has induced me to trouble you with this note. I may also say that the bone-bed crops out in the Blue Lias between Penarth Head and Lavernock, near Cardiff. I have a slab of the bone-bed from this place, the finest I have ever seen, literally full of small reptilian bones, coprolites, fish-scales and fish-teeth.

Hoping this communication will not trespass too much on your valuable space, —Yours truly, NORMAN GLASS, Kensington.

THE GEOLOGY OF ATHLONE.—DEAR SIR,—In sending you a brief account of the Geology of Athlone district, but more particularly of the Mountain Limestone formation so amply developed in this neighbourhood, I shall have to depend almost entirely upon what I have seen, and deal only with what I have thought. In my investigations here I have had but little help from books, less from men. When I came to Athlone in January, 1859, I came from the chalk-hills of Hampshire, and all the knowledge that I possessed of the Mountain-limestone and its fossils, and of the Carboniferous system generally, was derived from a casual reading of Hugh Miller's "Old Red Sandstone," and Page's "Introductory Text Book of Geology." However, when I had settled down and begun the study of geology in earnest, I set myself rather a difficult task, to find out—unassisted by books or friendly counsel—the fossil wealth of the limestone beds in this locality. I can assure you this has been to me a very pleasant occupation, and each new discovery has given me an earnest of what I may expect in other places.

In drawing your attention to the fossils of this district, I shall dwell more particularly upon the Mollusca of the Mountain-Limestone than upon ought else. These I have found in abundance, and specimens of almost every species and genera named by David Page in his "Advanced Text-Book of Geology," as common to the Carboniferous limestone are to be found in any small collection. Of the Brachiopoda I have several species of *Productus*, *Terebratula*, *Spirifera*, and *Orthis*. Several species of *Lingula* and *Mytilus; Euomphalus* and *Bellerophon;* together with two or three species of *Orthoceras*, and others that I am unable to name. About fifty or sixty species in all, represented by numerous specimens embracing varieties and peculiarities, is no bad collection from one locality! That the Mountain Limestone formation is eminently fossiliferous there can be no doubt, but of the several beds I shall allude to in this letter only *one* had yielded me these treasures.

Within a short distance of Lough Ree, one of the principle lakes of the Shannon, but in different directions, there are three large quarries opened, in what I am inclined to consider are the upper, middle, and lower beds of the Carboniferous limestone. For convenience of reference I shall name them according to their several peculiarities. Beginning at the bottom they will stand thus:

I. "Encrinital" limestone,—Kil Toom, county Roscommon.
II. "Productus" and "Spirifer" limestone,—Coorsun Point, co. Westmeath
III. "Black" fissile and "Italy" limestone,—Ballykeyron, co. Westmeath.

Although these beds have but one appellation there is a wonderful difference in their composition. The "Encrinital" limestone of Kil Toom is almost wholly "made up" of jointed stems and branches—indurated by some process—of these extinct echinoderms. "These singular animals—the representatives, perhaps, of others now equally abundant, but of different appearance—were provided with means of secreting stony portions, which, when fitted together formed a moveable stone column, thickly ringed with branches similarly produced, and terminated by a cap, made also of stony plates fitting together, forming a stomach partly closed by a proboscis; also defended with innumerable arms, widely extended in a complicated fringe: this mass of living stone seems to have served as one of the scavengers of the deep—removing and assimilating the half decomposed animal-matter that would otherwise have proved injurious.

"While the Pentacrinite thus floated or waved about . . . the oysters of that time were planting themselves at intervals; and the Terebratula and Spirifers . . . appear to have found ample food in these seas swarming with life."*

The stony skeletons of these Encrinites lie almost always parallel, crosswise to the lines of bedding; and the successive "forests" seem to have spread their roots down and among the dead and decaying masses of a bygone race, and following each other to have built up the calcareous soil on which future generations lived. As in a forest of pines, where the underwood grows at will, we see many a diminutive plant spring up only to die before its natural term of existence is complete—crushed by the grosser and more rapid development of the underwood—so in that ancient sea the forests of towering Encrinites would tolerate an undergrowth of smaller species; but below these was no maturity for the millions who began to live, but were forced to yield before the gross and rapid growth of their taller neighbours. Their dead remains in the vicinity of the full-grown encrinites tell a tale not to be misunderstood: they speak a language to the geologist; may be a language he alone is privileged to interpret.

As the limestone lies in its natural position in the quarry, you may observe certain intersections parallel and perpendicular to the lines of bedding. The vertical ones filled with calc, so regular in its "infillings," that one could imagine that it formed a part of the stone in its original bedding; the others with a dark brownish clay, which is nothing more than the debris of the argillaceous components of the stone caused by continued dampness. The last are the "bottoms" of the quarrymen, and when the tabular masses are turned up and exposed to the action of the weather, the structure of the encrinital stems is distinctly visible: a calcareous stem, jointed with ring-like layers about the sixteenth of an inch in thickness. Each of these thin layers are marked with rays, which branch, vein-like, as they recede from the centre. I know nothing more beautiful or perfect than these fine rays on some of the larger stems of the encrinite. In all carboniferous limestone districts they have arrested the attention of even the most careless observers. The quarrymen and stonebreakers have told me that these markings have received more notice from them, on account of their peculiar minuteness, than the very curious "cockles" (*spirifers* and *producti*) so frequently met with. Is it strange that these should have attracted the notice of the early Britons, so fond as they were of ornaments, or even the prying eyes of the Roman warriors?† Well might the nuns of Lendisferne call the broken stems of the encrinite the beads of St. Cuthbert, and couple them with his memory; and Scott has shown his usual acumen in seizing the incident for a picture in his "Marmion."

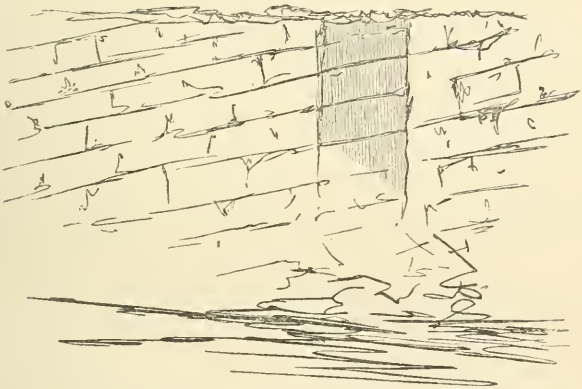
"But fain St. Hilda's nuns would learn
If on a rock by Lendisferne
St. Cuthbert sits, and toils to frame
The sea-born beads that bear his name.
Such tales had Whitby's fishers told,
And said they might his shape behold,
And hear his anvil sound.
A deadened clang, a huge dim form,
Seen but and heard, when gathering storm
And night were closing round."

* Ansted's "Geology," "Circle of the Sciences," p.p. 110-111.

† Dr. Mantell states that he has found quantities of these perforated ossicula, which had been worn as ornaments, in barrows of the ancient Britons. "Miller's Popular Geology," p. 187

On the upturned blocks I have examined thousands of these jointed stems, some eight, ten, and twelve inches in length; and though I have been able to detect what appears to me to be the roots, *in situ*, I have never yet been fortunate enough to obtain a specimen of the beautiful "cup-like" body of *Cyathocrinus*, or the more ornamental *Encrinus moniliformis*. There are several kinds of sea-lilies in the Mountain-limestone; and they range throughout the greater part of the paleozoic and secondary ages of our world's history. Their entombed remains form a large portion of the solid-work of our globe; and palaces, castles, churches, and huge bridges are being, and have been constructed of the rocks formed of their stony skeletons. The works of man, alas! are puny and insignificant compared with the mountain-accumulations of the Encrinites of the ancient seas.

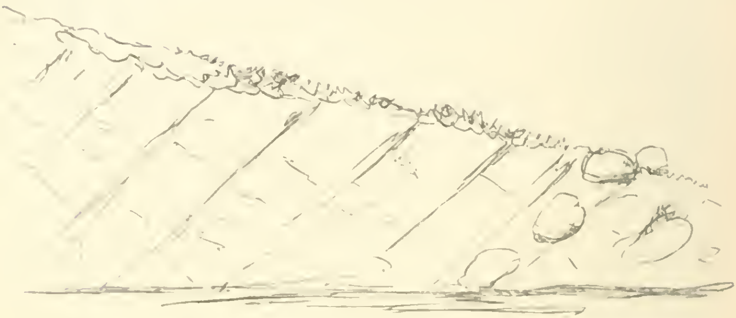
The Mollusca of the Kil Toom bed differ in no respect, so far as I am acquainted with them, from the Molusca of the Mountain-limestone generally. I will not, however, speak positively on this point. *Terebratulæ*, *Spirifers*, and *Producti* I have seen *in situ;* but specimens are very difficult to get, owing to the hardness of the stone. There are other fossils besides those I have named.



Mountain Limestone, Kil Toom. The stone crops out on a level with the road. Strike north and east. Dip east. Angle about 28 degrees. Depth 50 feet.

The next quarry of any note in the vicinity of Athlone is situated at Coorsan Point, on the eastern border of Lough Ree. There are two roads leading to the quarry: one by the river, through the village of Coorsan; the other by a house called—from a peculiarity in the architectural design—" Weligan's folly." The geological tourist should take the latter. Between the town and the lake many interesting sections of rocks belonging to the Drift-era will be observed on either side of the road. Huge boulders of Mountain-limestone, several tons in weight, lie scattered over the plains on either hand. At one particular spot, about midway between the town and the lake, it would be no unprofitable study if the tourist halted for an hour to examine the position of those boulders, how they rest upon the stratified sands and gravels, and how the atmosphere has made sad havoc with their exposed surfaces. These boulders may at one time have belonged to the Coorsan bed; but of this I should not like to speak positively.

In several of the smaller boulders I have found *Orthis resupinata*, and *Euomphalus pentangulata* in company with *Syringopora reticulata*. Now I have found *Orthis* and *Euomphalus* at Coorsan, but not *Syringopora*. I conclude, therefore, though not hastily, that these boulders may have belonged to some other exposed rock of Mountain-limestone further north.

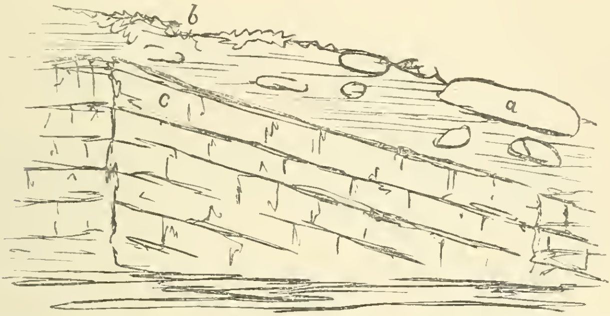


Mountain Limestone. Coorsan point (Lough Ree). Strike west and south, dip east. Crops out at the surface. Angle about 40 or 43 degrees.

I have so named the "Productus" and "Spirifer" limestones on account of the abundance of the fossil mollusca of these two forms. The quarry at Coorsan Point, on the borders of Lough Ree, have yielded me about ten species, besides Terebratula and Euomphalus. Here the young geologist may work with pleasure and never tire; and as he works hundreds of curious questions will arise and ask for solution. I stand on the summits of the quarry, with my back towards the lake and see before me the huge rock in which the encrinite is barely a predominating feature, but where thousands of Mollusca lie entombed. In some places there is a beautiful deposit of calcareous spar, fringed with metallic sulphide, marking the spot where there was a sudden extinction of life. There can be no mistake, for the molluscs are more numerous here than elsewhere.* How is this? Yonder on the opposite side of the same lake, with a dip eastward, and a strike north and south—the same dip and strike remember, of the stratum before me—thousands of Encrinites lie buried with but comparatively few Molluscs. How can we account for this difference? Far away, at Ballykeyron, with nearly the same strike and dip, another stone presents itself to the gaze of the geologist, black, bituminous, and shaly, almost destitute of fossils; and, according to the lime-burners destitute of lime. These three quarries show at least three states of the Mountain-limestone seas; how they were inhabited; and how their inhabitants lived and died. It would be useless to speculate on the probable thickness of each bed. Reckoned by years how many must have intervened between the first and last deposit of animal-matter in those palæozoic seas!

* In this quarry the formation of metallic sulphides is very common. "It affords an interesting proof that animal matter in a state of putrefaction proves a powerful agent in the decomposition of mineral substances held in solution, and in their consequent precipitation. An earthen pitcher, containing several ounces of sulphate of iron, had been suffered to remain unemptied and unwashed in a corner of Mr. Espy's laboratory for about a twelvemonth. Some [illegible] mice had [illegible] into it and been drowned; and when it at length came to be examined, [illegible] yellow sulphureous powder, mixed with hairs, were seen floating on the top, and the bones of the mice discovered lying at the bottom; and it was found that [illegible] decaying bodies the mineral components of the fluid had been separated and precipitated in a dark-coloured sediment, *consisting of grains of pyrites and of sulphur*, of copperas in its green and crystalline form, and of black oxide of iron. The animal and mineral matters had mutually acted upon one another; and the metallic sulphate, deprived of its oxygen in the process, had thus cast down its ingredients."—Hugh Miller's "Old Red Sandstone," 7th ed., p. 247. Was it a solution of sulphate of iron caused the sudden death of the molluscs in the Mountain Limestone seas?

Shall the wit of man ever divine, or will he ever approach to even a proximate calculation? Indeed. no! It is not by years, but by indefinite ages and eöns, that the geologist alone can speak of the progress of life in time.



Mountain Limestone, Balleykeyron. *a*, rolled boulder of Mountain Limestone, probably from some bed further north. *b*, drift boulders and clay. *c*, quarried stone and shales.

When I began this letter I had many a question to put, but these I must leave for the present. I have looked upon these now familiar rocks for the last time for many years to come, and I will keep my questions to ponder over in some new locality. Should these "notes" induce any wandering geologist in Ireland to spend a few hours or a few days in Athlone, I would advise him to go direct to the quarry at Coorsan Point, with hammer and bag, and should he use his eyes as well as I have used mine, he cannot fail to find good specimens of the following fossils.

The following is a List of Fossils to be met with in Athlone. Those marked with asterisks are common; the others are more rare.

Clisophyllum
* Amplexus corrolloides.
* Encrinites, of several species
Hemitripa Hibernica
Fenestella
Terebratula saculus
* ,, hastata†
* Athyris Roysii
,, lamellosa
* ,, subtilita
,, planosulcata
* Spirifera striatus *
* ,, ellipticus [Coorsan and Kil
* ,, attenuatus Toom]
,, cuspidatus
,, ovalis
,, duplicicosta
* ,, bisulcatus

* Rhynchonella pugnus
* ,, pleurodon
,, flexistria
,, accuminata
* Orthis resupinata
,, Michelini
* Productus plicatus } Coorsan
* ,, Martinii } and
* ,, semireticulatus } Kil
* ,, punctatus } Toom
Lithodomus, two species
Euomphalus pentangulatus
* ,, Dionysii
Waticopsis Philipsii
* Turritella
* Loxonena constricta
Melania constricta (?)
* Goniatites truncatus

† And what I am inclined to regard, after what has been said by Mr. Davidson as several varieties of *hastata*.

* Spirifera glabra	Coorsan and Kil	* Nautilus
* ,, imbricatus	Toom]	Orthoceras paradoxicum
,, lineatus		,, ovalis
Rhynchonella reniformis		,, sp. unnamed

The following are occasionally met with at Coorsan.

Trilobite (Griffithides) longiceps	Pleurorhynchus hibernicus
Strophomene analaga	,, minax (?)
Lucina Egertoni	

GEORGE ROBERT VINE.

ON THE OOLITIC ECHINODERMATA OF THE NEIGHBOURHOOD OF OXFORD.—As our knowledge of the geographical distribution of the Oolitic Echinodermata is very imperfect, the following list of species collected by myself and others in the neighbourhood of Oxford may not be unacceptable, as tending, though but in a small degree, to add to our stock of information on this point.

Cidaris Smithii, Wright. With the jaws preserved, in the Coralline Oolite, Bullingdon, where the spines are also occasionally found.

Cidaris florigemma, Phillips. In the same quarry with the following (opposite the play-ground belonging to Cowley School), where I have found the test: the spines are profusely common everywhere in the Coralline Oolite.

Cidaris Bradfordensis, Wright; Plates and perfect spines occur in the Islip Cornbrash

Hemicidaris intermedia, Fleming. Coralline Oolite, in several quarries on Bullingdon, but rare.

Hemicidaris Stokesii, Wright. Stonesfield slate, of Stonesfield. Found by Mr. C. Stokes and Prof. Phillips.

Pseudodiadema Parkinsoni, Desor. Stonesfield slate. See Dr. Wright's monograph.

Pseudodiadema versipora, Phillips. Rare in the Coralline Oolite at Bullingdon. In the same formation at Farringdon it is much more common.

Hemipedina Marchamensis, Wright. Lower calcareous grit, Marcham. Discovered there by the Hon. R. Marsham.

Pedina Smithii, Forbes. From the Islip Cornbrach. I have procured a single complete specimen from this species, the only one known.

Stomechinus intermedius, Agassiz. Two specimens have occurred to me in the Kidlington Cornbrash, one with several spines *in situ*.

Acrosalenia hemicidaroides, Wright. Cornbrash, Islip. Common. Great Oolite, Stonesfield, and Kirtlington railway-station.

Acrosalenia pustulata, Forbes. "Great Oolite, near Woodstock. Mr. Gavey, near Kiddington; Mr. Dominicke Browne." I have not met with it myself.

Acrosalenia spinosa, Forbes. Cornbrash, Islip and Kidlington.

Holectypus depressus, Leske. Inferior Oolite, Charlbury, Cornbrash, Islip.

Pygaster umbrella, Agassiz. Coralline Oolite, Bullingdon.

Hyboclypus gibberulus, Agassiz. Inferior Oolite, Charlbury.

Echinobrissus clunicularis, Llhwyd. Inferior Oolite, Charlbury. Cornbrash, Islip, Kidlington, &c.; abundant.

Echinobrissus Woodwardii, Wright. Great Oolite, Stonesfield, in the railway cutting nearly opposite the village.

Echinobrissus Griesbachii, Wright. Great Oolite, Stonesfield.

Echinobrissus scutatus, Lam. Common everywhere in the neighbourhood of Oxford, in the lower calcareous grit.

Echinobrissus Brodiei, Wright. Portland Oolite, Brill, where it was discovered by the Rev. P. B. Brodie.

Clypeus Plotii, Klein. Upper Zone of Great Oolite, Enslow-bridge; fine and frequent. Stonesfield slate, of Stonesfield, according to Dr. Wright.

Clypeus Mulleri, Wright. Great Oolite of Emslow-bridge, and of the railway cutting near Stonesfield.

Pygurus Michelini, Cotteau. Cornbrash, Islip; but not common.

Pygurus pentagonalis, Phillips. Coralline Oolite, Bullingdon; very rare.—J. F. WHITEAVES, F.G.S.

STARFISH IN THE DEEP OCEAN.—Sir,—In the article on "High and Low Life" by Mr. Roberts, the following passage occurs: "The enormous pressure of the opposite element (water), which in the homes of these starfishes must amount to at least a ton and a half on the square inch, is so greatly at variance with our belief, that we are confounded at the very outset of the inquiry." Why cannot the possibility of a starfish existing under such enormous pressure be accounted for on the same principle as the fact that our own species exists under a pressure sufficient to crush us to death? Myself and a fellow student having discussed the point without arriving at any satisfactory conclusion, we shall feel greatly obliged if you will kindly enlighten us.—Yours, &c., G. H. and J. R. B.

ON LOWER LIAS SUB-DIVISIONS—A German sub-division of the Lower Lias is into zones named after their leading fossils. The beds lying consecutively under the *Ammonites oxynotus bed*, are called by Oppel, one the "Obtusus Bed" *(Ammonites obtusus)*, the other the "Tuberculatus Bed" *(Pentacrinites tuberculatus)*, The beds in England said to correspond with these have been recently, in accordance with the German method, named in the same way, except that the latter name is rejected in favour of an ammonite, *A. Turneri.*

The correlation stands thus:—

	Germany.	*England.*
Zone of *A. Oxynotus.*	Amm. Obtusus Bed	Amm. Obtusus Bed=(A.)
Zone of *A. Bucklandi.*	Pentac. Tuberculatus Bed =	Amm. Turneri Bed =(B).

Now all this rigid zone-dividing looks well enough within doors, and I fervently hope it may be found equally to correspond with nature's pages, remembering that a bad index to a book is worse than none at all. But that is not the subject of my present inquiry. I wish now simply to question the correctness and advisedness of the above partition, so far as the Lower Lias in England is concerned. It must be admitted that if a bed be named after a leading fossil which prevails therein, the fossil selected for a key-ward to the bed should be distinct and characteristic, else it is of feeble service for the purpose of nomenclature and classification of strata. To come to particulars:—If, in a bed (A + B), the upper part of the bed (A) contains any number of x's, and the lower part (B) any number of y's;—then if $x=y$, or if x differs from y by an almost inappreciable difference—it, of course, follows that for all practicable purposes A=B: that the bed (A + B) should not be split on such evidence, but be regarded as one zone.

Such is the case with the above beds, the "Obtusus" and the "Turneri." The above reasoning is applicable; and before the sub-division of the bed marked A. B. be accepted, let the palæontologists first settle the question of their guide-shells. It will be of service then to put the query does A. obtusus differ from A Turneri? Rather does not Amm. Turneri = A. obtusus = A. Smithii = A. stellaris?

If the latter is the case let us reject *A. Turneri* for a name yielding us a more distinct guidance: or call both divisions the "*A. obtusus Zone.*"

POSTSCRIPT TO MR. POWRIE'S LETTER ON CEPHALASPIS.—The following postscript to Mr. Powrie's letter on Cephalaspis has just reached us. ED. GEOL. "Reswallie, March 26. Since sending off my short notice of Cephalaspis I have, only yesterday, been able to add to those already noticed another Scottish locality which promises to be moderately rich in remains of this fish; having discovered a few imperfect heads in a quarry opened in a wooded hill a little north of Westerton house, near Bridge of Allan, in Perthshire. I would not have thought this deserving of notice had I not in the same place found two heads, undoubtedly of the nearly allied genus Pteraspis, being so far as I am aware the first specimen of this fish recognised in Scotland. I am not sufficiently acquainted with the English specimens of this genus to be able to say whether the two I have found are specifically the same with any of these, or whether they may form an entirely new species."—J. POWRIE.

REVIEWS.

Old Bones; or, Notes for Young Naturalists. By Rev. W. S. Symonds. London: Hardwicke. 1861.

Old Bones amongst our fore-fathers were of little value indeed, but modern manufactures and chemistry have made them a valuable commodity. Geologists, too, have found a value in Old Bones beyond any ideas of manufacturers or domestics. From the old bones of animals that lived in the vastly remote periods of Geological History the paleontologist develops the ideal forms of beings long since extinct and perished from the face of the earth. These he mentally clothes anew with muscles and with flesh, and furnishes us from those dried and stony relics with real accounts of the habits and natures of the beasts and reptiles, fish and birds of lands and seas the eye of man ne'er gazed on.

We all know Mr. Symonds' other popular little books, and this will be not less a favourite. All Mr. Symonds does he does well; but of the illustrations we can only say that they are judiciously selected, and that their execution is as good—or as bad—as in the generality of modern popular geological works, in which the illustrations rarely have any pretensions to truthful or artistic merit.

The Dublin Quarterly Journal of Science. Edited by the Rev. S. Haughton, M.A., F.R.S. Dublin: McGlashan and Gill. 1861.

Although our space this month is greatly restricted, and we are still obliged to leave over until future numbers a great quantity of valuable matter in hand, we would not willingly allow the present occasion to pass without a few lines of congratulation on the appearance of another excellent scientific periodical, the Dublin Quarterly Journal of Science, to which we wish every success, as doubtless will be attained under the able direction of Professor Haughton.

THE GEOLOGIST.

MAY, 1861.

A LECTURE ON "COAL."

BY J. W. SALTER, F.G.S.

(Continued from page 131.)

There is less to be said about the animals found fossil in the coal than about the plants. And for this reason, that the vegetables formed the coal; the shells and crustaceous creatures, and fish, and reptiles, were but visitors: or if they lived upon the spot, bore no larger proportion to the stately jungle that sheltered them, than the denizens of our own forests now-a-days do to the trees and undergrowth which give them food and habitation.

Still, animals are far from rare; and the common ones are chiefly *bivalve shells* and *worms*. The truly land animals are but few. A rare insect or two has been found in our own country. Dr. Mantell discovered the wing of a fly not unlike the dragon-fly, and supposed to belong to the American genus *Corydalis*. This insect is figured in Sir R. I. Murchison's Siluria,* and is now in the British Museum. And one or two beetles, or rather what have been supposed to be beetles, have been found in Coalbrooke Dale. Cockroaches and crickets have left their wings in tolerable plenty in the coal-shales of Saxony.† No doubt they were welcome there amid the coal-solitudes, and put a little life into them. They are far from welcome now. I recommend all who may live in the neighbourhood of the coals to give a little time to hunting for the relics of these old

* 2nd Ed. 1859, p. 321.

† See Dunker and Von Meyer, Palæontographica, vol. iv

insects, &c. They will probably be rewarded by finding some wing-cases of Orthopterous tribes, and it will be their first discovery in Britain.

Arachnida (that is, spiders and scorpions) were probably not rare in the coal-period. A fossil scorpion was found at Prague; and unless I am very much mistaken, I have seen relics of more than one large spider from Coalbrooke Dale, in Shropshire.

In those celebrated trees described by Professor Dawson and Sir Charles Lyell,* and which were found in the sandstone of Nova Scotia, millepedes (*Xylobius*), or at all events some members of the myriapod group, were found. They were associated, in the same hollow stumps, with numerous small land-snails. These were somewhat like the little Pupa, or chrysalis snail, so common on moss-grown trees, in the deep woods of Old England. But I shall never believe that coal-forests were like the woods of our own times, for reasons which will immediately appear.

Fig. 1.— *Pupa v tusta.*

One word, though, about the other land animals found in these trees, for Prof. Dawson in his last communication to the Geological Society,† makes it extremely probable that there were land lizards to feed on and restrain this insect-life within due bounds. They may have been amphibious lizards—the larger species (*Dendrerpeton Acadianum*), found in the coal-measures, certainly was so—yet the nature of the teeth of another (the *Hylonomus*), and its scaly armour, look too much like those of living land lizards, to allow us readily to believe that it too was a Batrachian reptile, modified for and adapted to this sort of life. We must wait for more complete information.

And now, with all these proofs that the creatures of the land lived and died in the old coal-forests, why should we refuse to believe that these grew upon dry land?

That dry land was not far off, I must, of course, admit. The muddy sediment and sand that form the mass of the coal-measures were derived from land; and must have been formed, as sand and mud are now formed, by the washing away of rock and earth—the daily action of the tides and rivers.

But the question is, whether the plants grew on the land, and were then submerged; or whether they grew in the water, and so were mixed with the "spoils of animals, savage and tame," that lived in the water.

The commonest fossil in the coal measures—the one which *par excellence*, is "the coal fossil"—is the *Anthracosia*, or Unio, as it used to be called.

This is a bivalve shell with closed valves, looking not at all unlike the common Unios of our streams, but never showing any of those peculiar wrinkles about the beak, which living *Unios* always exhibit.

* Quart. Journ. Geol. Society, vol. ix., p. 58.
† Ibid. vol. xvi, p. 275.

The hinge, when the valves are opened—they are rarely so—does not present the usual teeth of Unio; but the binding ligament of the hinge has nearly the same position. Moreover, the Unio shell has—besides the scars left by the two great muscles which close the shell—a smaller scar (or even two) next to the front muscles; and this is absent in the fossil. Professor King, of Galway, a close observer of the insides of "auld warld" shells, established this fact, and distinguished the fossil from Unio by means of it. He called the coal-shell *Anthracosia*, a very appropriate and even classical name. I heartily wish all palæontological names were so!

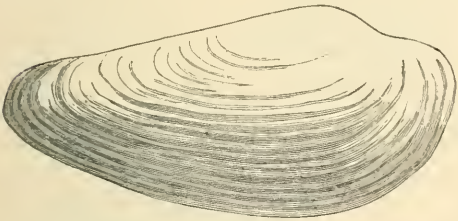


Fig. 2.—*Anthracosia* (Unio) *acuta*, Sowerby.

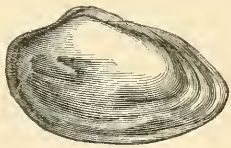


Fig. 3.—*A. ovalis*, Martin,

And I find, on carefully looking over a number of specimens, that every now and then one shows the whole surface of the shell wrinkled, not the beak merely, but the broad surface of the shell itself. This also is a character not found in the true Unio; but is common to all the mud-burrowing tribes of the myadæ or "gapers;" and to this tribe I would refer the shells in question.

The more so, as another shell often accompanies the *Anthracosia*, which clearly belongs to some family of mud-burrowing shells. It has the surface strongly wrinkled; and these wrinkles are of such a shape as to indicate the existence of a rough strong envelope to the tubes of the mantle, like those of the *Mya*. Here is a sketch of the living Mya or "gaper," as it stands head downwards in its muddy home; and side by side with it is the shell I have referred to, called by me *Anthracomya*. These really are the principal shells throughout the greater part of the coal-measures. And, so far as we know, all such shells must have lived in salt-water,—though I am bound to say that an eminent man who has lately written on the shells of the coal of Germany, considers that some of them are like the freshwater muscle *Dreissena*. I do not believe

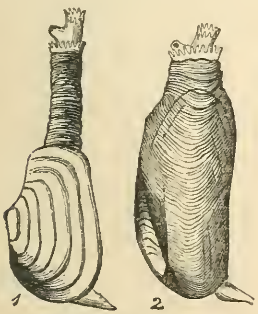


Fig. 4.—*Mya truncata*, with its rough tube (Woodward).
Fig. 5.—*Anthracomya senex*, with its tube and foot restored.

it, but I believe he thinks so, and it is a very excellent suggestion—for the shape is very like.*

But in the lower part of the coal-formation, and in one or two beds also in the upper portions, there are none but truly sea-shells. It would take long to enumerate them; but I need only mention one or two familiar names. *Avicula*, or rather a shell between *Avicula*

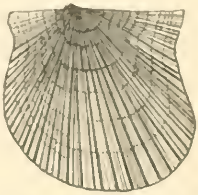


Fig. 6.—*Aviculopecten papyraceus*, Sow.

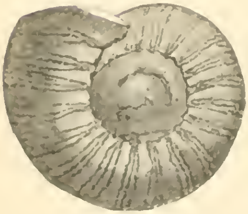


Fig. 7.—*Goniatites Listeri*, Sow.

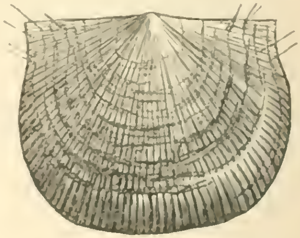


Fig. 8.—*Productus semireticulatus*, Martin.

(the pearl oyster), and *Pecten* (the scallop), and therefore called *Aviculopecten*, fig. 1. *Goniatites*, fig. 2, a shell which is a near relation to the nautilus. The nautilus itself is common enough. *Nucula*, a true sea-shell, is with them; and, to name no more, the *Productus* (fig. 3), which is found everywhere in the mountain limestone, must have been deposited in sea-water—and deep sea, too—for it is found with corals and fish, sea-fans and sea-lilies; and belongs to a group of shells which never quits the open sea.

Perhaps we need not dwell upon the shells any more; suffice it that those of the bottom of the coal-measures are all marine, and those of the top parts are not much like freshwater ones, and from the company they keep, were probably marine too.

* This author, Rudolph Ludwig (Dunker and Meyer's Palæontographica, vol. 8, pl. iv., v.; and vol. 10, pl. lxxi., lxxii.), in his papers on the "Naiades of the Coal Measures of Westphalia," thinks he has detected the freshwater shells *Cyrena*, *Anodon*, *Unio*; all of which are, I believe, *Anthracosia*; and also *Dreissena*, one of which at least is an *Anthracomya*. He also quotes *Planorbis*! but the little shell which goes under this name is the *Spirorbis*, mentioned further on.

For with these shells, and attached to the plants that lie among, and above, and beneath the shell-beds, is found abundantly a little sea-worm, or rather the spiral case of a sea-worm (*Spirorbis*, fig. 4), which is as well known now upon sea-wrack and kelp, as it was upon floating leaves and plant-stems in the coal-period. It is called *Sp. carbonarius* from its habitation in the coal.

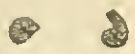


Fig. 8.—*Spirorbis carbonarius.*

And there were sea-crabs—not, it is true, like English ones—but like the king-crab (*Limulus*) of American waters. And shrimps though rare, were not quite absent. And sharks swam in the water; for we find their teeth and fin-bones. And other strange uncouth fish, more like the bony pike of America than aught else. This is a freshwater fish, and tells rather against my opinion; but all I can say is, that if the coal-fishes were not saltwater fishes, they had no business among saltwater shells and crustacea, and they must take the consequences.

But how reconcile saltwater and its inhabitants with lofty trees, and a thick jungle, and delicate ferns; and colonies of insects, and spiders, and scorpions, and lizards?

No doubt this is a difficulty. Most authors who have written on the coal have taken it for granted that it must have been formed in mighty swamps at the mouths of rivers, with only frequent access of the sea; with much dry land in the neighbourhood to supply the ferns and firwood, and permit the growth of a thick underwood such as certainly must have formed the coal.

But others, and amongst these I must name Prof. Henry Rogers of America, and our own Mr. Binney chief*, have not shrunk from the supposition that the *Sigillaria* grew on the sea-bed itself.

"Only one particular process," says Prof. Rogers, "promises to explain the occurrence of these thin and uniform sheets of material, of which the thickness is often less than a foot, while their superficial area is many hundred square miles. I cannot conceive any state of the surface but that in which the margin of the sea was occupied by *vast marine savannahs* of some peat-forming plant, growing half-immersed on a horizontal plane, fringed and interspersed with forests of trees, shedding their leaves upon the marsh. Such are the only circumstances under which I can imagine these regularly parallel, thin, widely-extended sheets of carbonaceous matter could have been accumulated."

The smooth surface of the underclay formed a fit nidus for the young plants, and as the deposit went on, they struck their roots far and wide into it, and grew to their full stature. These trees formed the bulk of the coal-forest. The interstices were filled with the reedy plants, Asterophyllites, Calamites, and sedges, with many a Lepidodendron and coniferous tree; and as the decaying leaves and

* Trans. of the Association of American Geologists and Naturalists, 1842, p. 433. Binney, Manch. Geol. Trans. vol. i., p. 172, 1840.

branches fell off in myriads, with fruits, and catkins, and seeds, they formed a matted mass in the sluggish water.

On the stumps of the decaying trees the ferns would grow, and I have seen markings on a *Sigillaria* which induce me to believe this was really the case; and the hollow trees would form a safe retreat for such wingless insects, snails, or lizards, as the forest possessed.

Lest this should be thought a wholly anomalous state of things, we have, as an instance, the mangrove swamps of tropical countries, where, in the saltwater lagoons, whole forests of trees grow, among whose roots fish and crustacea find protection, and sea-shells are abundant. A species of oyster is commonly attached to the stems and the submerged branches. And if the *Unio* of the coal must be regarded as an *Unio*, there are even kinds of this genus which live in these putrid swamps.

For it must not be supposed that the trees grew in an open sea. Shallow tracts, shut out from the main ocean by spits of sand and sandbanks, and scarcely, if at all, subject to tides, are the state of things that prevail in many a lagoon now; and in all probability such was the case in the coal epoch. In such localities it might be expected that we should find creatures admirably adapted to their habitation, but unlike the ordinary denizens of sea or lake. The quantity of decaying vegetation would give a black colour to the mud, and coal shales are very black indeed: occasional currents would bring sand from seaward, and sandstones are common things in the coal-formation. If the ocean got free entry for a while, we should have colonies of true sea animals (the *Goniatites* and *Avicula* before mentioned), and such do every now and then occur. But the ordinary inhabitants of these delightful muddy creeks, half smothered in a thick forest of water-loving plants, would be the shells and crustacea suited to the locality, *i. e.*, the *Anthracosia* or *Unio* and the *Limulus*. Crowds of minute water-fleas (*Cypris* and *Cythere*), such as live in stagnant waters now, are found in the coal-measures. Thousands of worms, of all sizes, burrowed in the silt, and revelled in the feast of fat things that were putrifying there.

I believe this picture gives the true aspect of the dank and luxuriant vegetation, flourishing in a sullen steaming atmosphere heavy with miasmatous vapours; uncheered by the song of birds, scarcely musical with the hum of insects, and varied by no flowers, no trees yielding fruit, whose seed was in itself! Such a habitation was not fit for man—not even for the quadrupeds he delights to call his own. It was the ground-plan and first outline only of a picture, to be filled up during succeeding geologic times, and exquisitely finished before man was placed upon the earth.

What effect must all this mass of vegetation have produced on the surrounding air and water? Plants, we know, are chiefly formed of carbon, taken into their substance from the air and water, under the form of carbonic acid. They have the power of secreting the carbon from it, and they set free the oxygen for the use of animals. So that an atmosphere in a confined spot is actually purer—more oxygen, less carbonic acid—after a plant has grown in it than before. True, they give out carbonic acid at night, but not so much as they take in. All the plant (except water) is so much gained from this carbonic acid. Hence, the air is purified by plants.

Now coal being of vegetable origin, it is calculated that for every pound of coal, all this carbon, and at least two pounds of *water* have disappeared from the atmosphere. And if we consider the millions upon millions of tons, fixed in solid black masses in the crust of the earth, we must see that we are living in an atmosphere far purer, and more fit for the respiration of the higher animals, than it could have been without the aid of coal.

It may have been, as the sagacious De la Beche observed, that this enormous supply of carbonic acid was due to the ejections from many volcanic mouths, which we know breathed forth their fiery exhalations in coal times. It is also true, as Sir C. Lyell has said, that these gases so readily mix with the atmosphere, that little appreciable difference would be made by any quantity of volcanic action. But look at the subject in any light we may, there was the carbonic acid in the air, and there it now is, for our benefit, in the earth.

This rank vegetable produce, then, of quick growth and soft tissue —constantly wet, fermenting as soon as covered up—its heat kept in by a blanket of wet sand or clay, with pressure for ages, gives us all the conditions necessary for the production of lignite, brown coal, jet, and pit-coal; and when volcanic heat had driven away its gaseous parts, and left the carbon pure—even anthracite.

As this month's communication has extended to an unreasonable length, I will not now enter into the question of the different qualities of coal, or its uses, but defer what little I have to say on those subjects till next month.

SOME REMARKS ON MR. DARWIN'S THEORY.

By Frederick Wollaston Hutton, F.G.S.

(*Continued from page* 136).

But there are other causes that have tended to modify animals; such as habit, use or disuse of any particular organ, food, climate, &c., and these together with the fact that a variation which appears in the parent, at any period of its existence, tends to re-appear in the offspring at the same period, will enable us to account for the metamorphoses of insects, the differences of colour in the young and the adult, the horns of sheep and cattle, &c. If to these we add that of "sexual selection,"* we can see why sexes differ in organs and pro-

* Sexual Selection may be defined as the preference shown by an individual of one sex for an individual of the other from superior beauty of colour, shape, voice, &c.

perties. In fact most of the facts in natural history can be explained by this theory; but there are a few which at present cannot, such as the colours of certain larvæ, which are asexual. Even these may perhaps be the effects of the mysterious and unknown laws of correlation of growth and sympathy between different parts.

We must remember that the theory of natural selection is subordinate to, and totally distinct from, that of the transmutation of species; and that if the former should be found wanting it would not effect the latter in the least degree.

The third great argument urged against the theory of transmutation of species is the geological one; and may be divided into two heads.

1. The almost entire absence* of the remains of the numerous connecting links that must have existed.
2. The sudden appearance of groups of allied species, particularly in the lowest known fossiliferous formations.

The answer to the first is that the geological record is extremely imperfect. There are reasons for thinking that most sedimentary strata have been formed during subsidence. Besides the difficulty of accounting for the very thick ones in any other way, we must remember that during subsidence a newly-formed deposit has the advantage of remaining quiet until it has had time either to harden or to be covered up. When land is rising, on the contrary, the loose deposits will be continually washed further and further away from it until a period of rest or subsidence gives them time to consolidate; but while subsidence is going on the land and the inhabitable part of the sea will be decreasing, consequently there will be much extinction and little variation. When land is being elevated the contrary will obtain, therefore, most of the intermediate varieties will not be preserved.

Most sandstones and clays have been accumulated near land; for the finest mud or sand must sink before it can travel very far. Even in the exceptional case of the mouth of a great river, sediment has never been detected more than three hundred miles from the land. If rolled along the bottom by a current it would be stopped by the first valley it came across, which would act as a purifier to the current in the same way that a lake does to a river. Limestones may certainly be formed at any depth; but we have proofs in the organic remains of which they are generally full that most of them were deposited in not very deep water; and although some, like chalk, may be forming in the middle of the ocean, yet I think that the purity of deep water in most places, as proved by its blue colour,† is a sufficient guarantee that no deposition is going on; and that this is true is

* One reviewer has even said the "thorough and complete absence." See An. Nat. Hist. Feb. 1860, p. 140.

* It is the purity, not the depth of the blue that proves the absence of sediment; the depth of colour depends in a great measure on the quantity of salt it contains in solution. The North Atlantic between Ireland and Canada is not pure blue.

proved by the small horizontal extent of the various deposits which make up a formation, and which generally extend further in proportion to the fineness of the sediment of which they are composed. I think, therefore, that even taking into consideration submarine volcanos, we may safely conclude that no deposition is going on now over at least one-fifth of the area of the ocean.

In the present state of the globe about one-fourth of its surface is land: if we add to this one-fifth of the ocean we have two-fifths of the surface of the globe on which no deposition is taking place; and when we think that deposition could never have been universal, but that there must always have been large areas of denudation, we may feel sure that this is not very far from the truth. We may therefore conclude that the periods of repose in any one area are to the periods of deposition in about the ratio of two to three.

We now know that the deep sea is inhabited; and if we suppose that on equal areas the average number of the inhabitants of the shallow sea are to those of the deep sea as eight to one, and to the inhabitants of the land as one to three and a half—both suppositions may, I think, be safely made—we find that the number of the inhabitants of the areas of repose are to the number of the inhabitants of the areas of deposition as three is to two. It therefore follows that at least one-half of the animals and plants live in places where their remains can only be very rarely preserved. And this calculation will apply also to the ancient world; for if the present ratio of land to water, viz. one-third, should not be the average we should still arrive at very nearly the same conclusion; for if it should be greater, it is evident that the ratio of the inhabitants of the areas of repose to those of the areas of deposition would be increased; if, on the contrary it should be less, the land would be more divided into islands, with of course a larger coast line and larger areas of shallow sea; but the supply of sediment from the land would also be reduced and many parts of the shallow sea, which if near a continent would be areas of deposition, will near an island be areas of repose, while at the same time they will be, perhaps, more thickly inhabited.

But even where deposition is taking place, the burying of organic remains in all deposits but limestone is perhaps the exception, and not the rule. For if the deposition is rapid vegetable life, and consequently animal life, cannot flourish. If on the contrary it is slow, all bodies must lie for a long time uncovered on the bed of the sea, while there all the soft parts will either be eaten or decay, and the rest, subjected to the action of the tides or currents, which are generally found where deposition is going on, will often be broken, worn down, and destroyed.

From these considerations we must infer that the number of organic remains imbedded bears but a small proportion to those that have lived. But even after having been safely imbedded, the chances are much against a fossil ever finding its way into the cabinet of a collector. If buried in sand it is almost sure to be destroyed by the percolation of water, and all trace of it removed; and in any case it has to stand its chance of being obliterated by heat, or washed away by water.

As all sedimentary strata are deposited from water, it follows that for every cubic yard deposited a cubic yard must be denuded from some other place; and as the sedimentary rocks are much more common at the surface, and generally softer than the igneous ones, the burden of supplying the sediment falls chiefly on them. We may therefore feel sure that during any one period nearly as many fossiliferous strata are obliterated as are formed. In fact the power of denudation is so great, that Mr. Darwin and many other geologists think that only deposits formed during periods of subsidence are thick enough to resist its force, so that many species, and even genera, that had but a limited range may have been swept away, and all record of their existence destroyed.

This denudation added to the periods of repose will make the intervals between strata represent collectively far more time than the strata themselves, and we have many proofs that this is true in the numerous foreign strata that are intermediate in age to some of ours, in unconformability of stratification,* and in the abrupt change in the organic remains of consecutive formations.

Three-fourths of the globe are covered with water, therefore three-fourths of the strata that remain are hidden from us; and the other fourth has to be divided among all the formations that have as yet been recognised, for we can but examine the surface. Of the fourth that *is* accessible, not more than a fifth has been geologically explored;† and that only where sections happen to exist. We must also remember that large tracts of country, shown as Silurian, Devonian, &c., on our maps, are covered so deeply with drift and alluvium that they never have been, and perhaps never will be examined.

For all these reasons the geological record must be very imperfect, and when we examine it we find such to be the case; for we have no reason to suppose that the globe was less thickly inhabited in old times than now: on the contrary, when we find fossils at all they are generally in great abundance; yet the number in any one formation is almost as nothing compared to the number of living animals and plants.

Mr. Darwin has justly observed "that in order to get a perfect gradation between two forms in the upper and lower parts of the same formation the deposit must have gone on accumulating for a very long period, in order to have given time for the slow process of variation, hence the deposit will generally have to be a very thick one; and the species undergoing modification will have had to live on the same area throughout this time. But we have

* The conformability of one stratum to another is no proof of its close sequence; for strata are sometimes conformable in one place, and unconformable in another.

† By explored I mean the age of its strata well made out, not simply guessed at.

seen that a thick fossiliferous formation can only be accumulated during a period of subsidence; and to keep the depth approximately the same, which is necessary in order to enable the same species to live on the same space, the supply of sediment must nearly have counterbalanced the amount of subsidence. But this same movement of subsidence will often tend to sink the area whence the sediment is derived, and thus diminish the supply whilst the downward movement continues. In fact, this nearly balancing between the supply of sediment and the amount of subsidence is probably a rare contingency; for it has been observed by more than one palæontologist that very thick deposits are usually barren of organic remains, except near their upper or lower limits"*

We cannot, therefore, ever expect to fill up the gaps between different species and genera; still, in point of fact, there is nothing like "an entire absence of intermediate forms." All the fossils yet found are intermediate; and more than this, the older a form is the more it usually differs from living forms, and the more general is its structure. Trilobites, for instance, are more like the larvæ of living crustaceans than like the crustaceans themselves. "Owen has shown that the more generalized structure is, in a very significant degree, a characteristic of many extinct, as compared with recent, animals;"† and Mr. Woodward remarks "that the last developed groups are the most typical or characteristic of their class."‡

Next, with regard to the second part of the geological argument, I think that, remembering the imperfection of the geological record, it is very rash to affirm that "because certain genera or families are not found beneath a certain stage, therefore they did not exist before that stage," an argument that is being disproved almost every month. The progenitors of these genera may have lived long before, during the intervals that exist between the different strata, and were most likely developed during a period of elevation, and consequently when no record was kept of the event; but when the land became stationary and the conditions of life more fixed they would multiply rapidly, without much change, and spread far and wide: when a period of subsidence came their remains would be buried, perhaps in large quantities throughout the whole of the area over which they had spread. Mr. Darwin has also remarked "that it might require a long succession of ages to adapt an organism to some new and peculiar line of life, for instance to fly through the air; but when this had been effected, and a few species had thus acquired a great advantage over other organisms, a comparatively short time would be necessary to produce many divergent forms, which would be able to spread rapidly and widely throughout the world."§

It was shown long ago that different fossils came from different formations; and now, acting on this, if forms differ ever so little, or

* "On the Origin of Species," p. 295.

† Edinburgh Review, April, 1860, p. 507.

‡ "Recent and Fossil Shells," p. 417. See also p. 419.

§ "On the Origin of Species," p. 303.

even if they are positively identical, so long as they come from different formations they are classed by some palæontologists as separate species.

Migration too, must have played a very important part in the sudden appearance of species. And with regard to the first appearance of life, if even any of the remains of the oldest fossiliferous formation should still exist in that quarter of the globe which we can alone examine, it seems to me, when I think of the very small extent of country that has been geologically explored, extremely rash to infer that we have already found them.

When we take all these things into consideration we can, I think, easily account for groups of species coming apparently into the world at once; and that owing to the extreme imperfection of the geological record, we cannot ever expect to find all or most of the connecting links between species, or even feel surprised at their being absent. I therefore see no reason for disbelieving the theory on geological grounds; on the contrary, as we find that all the fossils yet brought to light *are* intermediate to living forms, they seem to my mind strong arguments in its favour.

I have, then, taken for granted that species vary, and have shown that not only has no limit been put as yet to that variation, but that the weight of the evidence is in favour of its extension.

I have taken for granted that natural selection is a "vera causa," and have, I think, shown that it is sufficiently powerful to produce the greatest differences that exist among organic forms.

I have shown that there is no real ground for dissent, because we have not yet found the missing connecting links, or because groups of species appear suddenly; but that on the contrary the geological argument is in its favour.

Therefore when we see that we can explain, by the transmutation of one species into another, nearly all the facts in the science of biology, we are, I think, entitled to look upon it as a very probable hypothesis—more probable than any other yet brought forward—and one that, by the clear and comprehensive views it gives of organic life, will lead to great discoveries. I do not wish to go further. I do not wish any one to "mistake the scaffold for the pile." I know that it rests at present on presumptive evidence alone, and that there are many "dilemmas" to be overcome before it can be accepted as true; but, in the words of Sir John Herschel, "are we to be deterred from framing hypotheses and constructing theories, because we meet with such dilemmas, and find ourselves frequently beyond our depths? Undoubtedly not."*

This is the mystery
Of this wonderful history,
And the way to find it out.—SOUTHEY.

* Discourse on the study of Natural Philosophy, p. 196.

DISTRIBUTION OF CEPHALASPIS AND PTERASPIS.

(Geol. vol. IV., p. 102 ; Ibid., p. 140)

Sir,—Before I trouble you with a few remarks in elucidation of the *apparent* difference between the views of Mr. Lightbody and my own, permit me to express the pleasure I feel at seeing his name so prominently in your columns. No man has studied with such untiring zeal the range and sequence of those interesting deposits which make up the Ludlow promontory; and I am glad to find that my own investigations, carried on independently of his, and at a distance from the field of work, have provoked so slight a bill of exceptions, and a few interesting notes, which I am sure every reader of "The Geologist" would be glad to see continued.

The head and front of my offending, as I learn it from my friend's comments is this: — I have called the "Passage-beds" Lower Tilestones; and out of this some confusion has arisen in minds which associate the word "tilestones," upper or lower, with those originally so-called, but known by Sir Roderick Murchison now as the Downton-beds. To make the position of Mr. Lightbody and myself quite clear to your readers, I will refer them to my section on p. 104. They will see that *above* the "Downton Sandstones" lies a zone which I have called "Lower Tilestones," and which is marked out by the number and variety of its fish-fossils. These beds are the "Passage-shales" of Murchison, which have been so industriously worked in their exposures in the Ludlow district (the chief of which are in the railway cutting near the station, and at the Tin Mill, about a mile distant) by my valued friend, Lightbody.

But now followeth my reason for not, in my humble sketch of ancient ichthyic life, retaining a name which has such high sanction. I rejected the term because it appeared to me to have less value as a designation for a special zone of deposit than the one I employed. The horizon of a "Passage-bed" must necessarily, from the character of the powers employed to deposit it, be a shifting one. True, that no name or term of designation we can apply to any rock, or zone of deposit, will be cosmopolitan in its value; but "Passage-beds" so called, have more troublesome equivalents than deposits nearer to the centre of a system, and in any endeavour to sketch out the range of life-remains, the term seemed to me peculiarly inappropriate. Upon this view of the case, I included all the beds beneath the "Upper Tilestones" of Trimpley—and as I still think of the Downton Hall drive quarry—under one name, as Lower Tilestones, representing them as resting upon the Downton series of sandy and "tiley" rocks. One good characteristic of the "Upper Tilestones" is their possession of an intercalated plant-bed, with good evidences of terrestrial vegetation. This, it must be remembered, is quite a distinct thing from the Downton plant-bed, which contains the *earliest* land-plants. The "*neutral* ground between the Downton and the (Upper) Tilestones" would have been clearly understood, had I introduced the bracketed word.

As regards the littoral evidence given by star-fishes, it certainly is not so strong as it was prior to the discovery of certain forms in the deep-sea; but the whole facies of the life-remains from the Lower Ludlow beds is indicative of a shallow sea-zone. The *Pterygotus* with its great succulent body, whose remains are met with above and below the Starfish-bed, could not have been a deep-sea creature: and other, but smaller, shrimp-like forms are met with associated with Bryozoans, and what appear to me to be *true* Fuci.

These are matters of much interest; and I am pleased to find that the torch of search I have kindled in the pages of "The Geologist," to explore the dim haunts of Cephalaspis, and his kinsman Pteraspis, is not likely to be soon put out. Chiefly will it be kept alight by contributions from men, like my friend Lightbody, who are familiar alike with the creatures themselves and the far-off kingdoms they inhabited.—I am, Sir, yours very truly, George E. Roberts.

ON NEW BRACHIOPODA, AND ON THE DEVELOPMENT OF THE LOOP IN TEREBRATELLA.

By Charles Moore, F.G.S.

(Continued from vol. iii., page 445.)

In addition to the Brachiopoda noticed in this paper, I am possessed of various minute specimens, which differ from any described species. Some of these may be the young of Brachiopoda that occur in the beds in which they are found; but until their passages into adult shells can be satisfactorily recognized, it will be undesirable to figure or describe them. Three examples of well marked and persistent forms are provisionally named and given below.

Spirifera minima. Moore. Pl. ii., figs. 19, 20.

Shell microscopic, often one sided or unsymmetrical, slightly rugose; valves moderately convex; deltidium triangular; area broad and flattened; hinge-line broad; front of shell rounded. In some specimens the shell presents a uniformly flattened surface, whilst in the majority the outer surface of the smaller valve possesses mesial folds, and in the larger valve a central sinus.

Obs.—This shell is not uncommon in the Inferior Oolite of Dundry. Although no internal characters have yet been noticed, there seems little doubt the shell must be referred to the genus Spirifera. It is perfectly distinct from a little shell found with it, described by me in the Somersetshire Proceedings for 1854. We have thus evidence of the presence of two species of this genus in oolitic strata, although in both instances they have become very degenerate in size. No larger specimens of the genus have yet been found in the same beds to which these diminutive shells can be referred.

Terebratula (?) minuta. Moore. Pl. ii., figs. 21, 22.

Shell very small, smooth, inequivalve, longitudinally oval, with large triangular deltidium; valves equally convex; hinge-line straight. The dorsal valve is usually square, and its inner side possesses a broad flattened septum, nearly the length of the shell, and dividing it into two equal portions.

Obs.—I have been unable to determine the form of the loop of this shell; and until this has been seen it will be doubtful whether it be a true Terebratula. Should it be such, it will be the smallest known species with which we are acquainted. It is from the coralline bed of Hampton Cliffs, Bath. It differs entirely from any other Terebratula found in the Great Oolite; and although so small, appears to present the characters of an adult shell.

Rhynchonella (?) coronata. Moore. Pl. ii., figs. 23—25.

Shell small, smooth, rounded; ventral valve rather convex; dorsal more flattened, and with a slight sinus; beak produced, with a large triangular deltidium, bordered by a narrow area, from which spring two raised lateral ear-like processes, which again fold over upon the area. Under the above the valve possesses strongly marked hinge-teeth.

The shell is from the Upper Lias of Ilminster, whence I have nine examples. The lateral ear-like expansions give to it a very peculiar appearance. With some little doubt it is referred to Rhynchonella, though the shell-structure appears to agree most with that genus.

In addition to the foregoing new species, the observations recorded in this paper show that the vertical range of other previously known Brachiopoda has been extended beyond the zones to which they were supposed to be confined. My friend Mr. Davidson, to whose kind hints I have always been indebted in my study of the Brachiopoda, has shown the continuity of some species in the Carboniferous and Permian eras; a fact which has since been more fully noticed by Mr. J. W. Kirby, in the Quarterly Journal of the Geological Society for November last, and in the same number may be found the interesting conclusions arrived at by Messrs. Jones and Parker bearing on this point, and having reference to the extraordinary range of some of the Foraminifera.

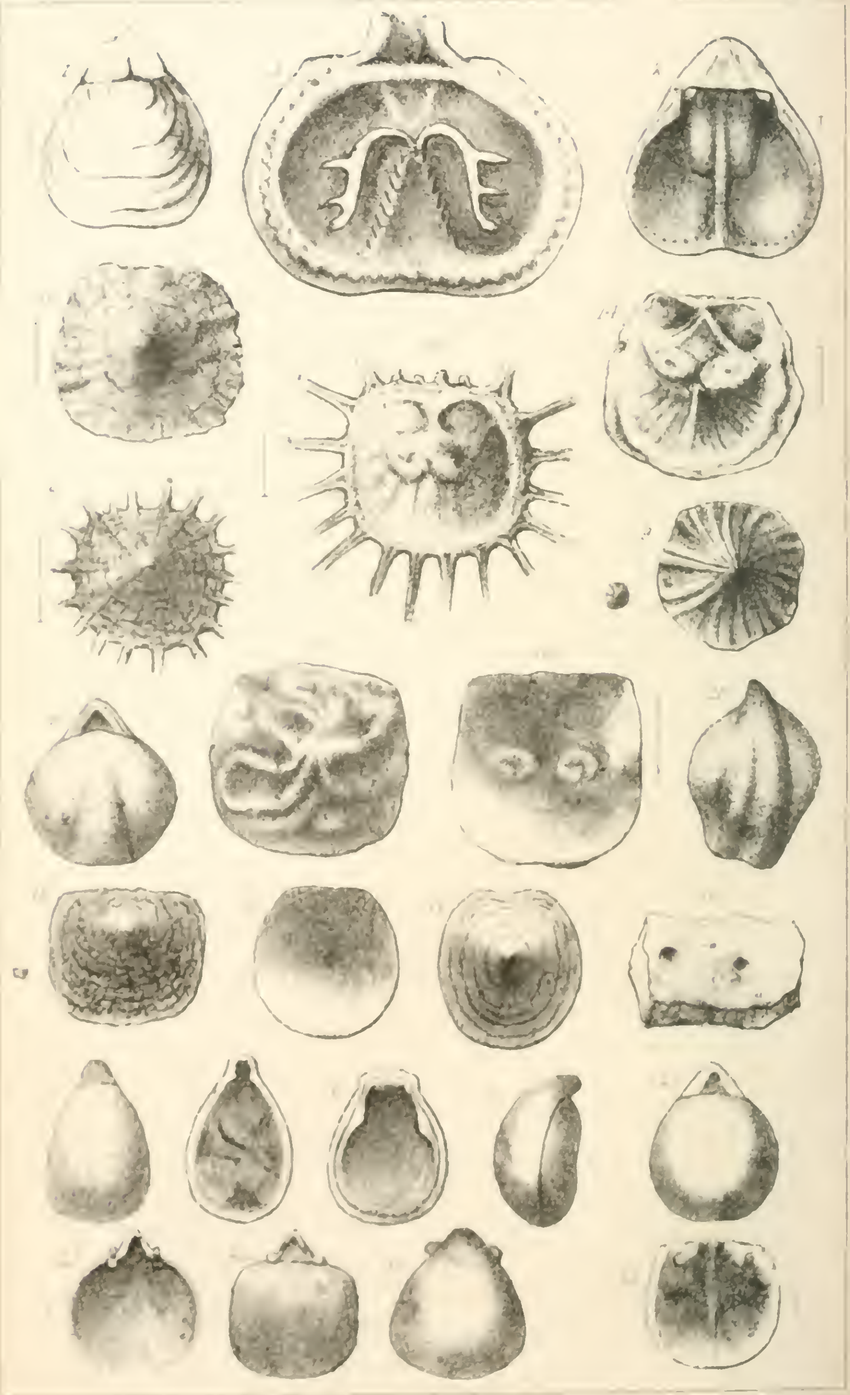
The range of specific forms is a question to which the attention of palæontologists should be especially directed.

The following table gives a list of new genera and species I have within a few years been successful in adding to British Brachiopoda, all of which are from the secondary beds of Somersetshire, except the *Thecideum ornatum* and *T. pygmæum*, which are from Wiltshire.

TABULAR VIEW OF ADDITIONS TO BRITISH SECONDARY BRACHIOPODA DISCOVERED BY THE AUTHOR, WITH THEIR STRATIGRAPHICAL DISTRIBUTION.

GENERA AND SPECIES:	Authority.	Lower Lias.	Middle Lias.	Upper Lias.	Inferior Oolite.	Fuller's Earth.	Great Oolite.	Bradford Clay.	Coral Rag.
Craniadæ									
Crania canalis	Moore				+				
——— *Ponsorti (?)*	Deslongchamps						+		
——— *Moorei*	Davidson			+					
——— *Sandersii*	Moore				+				
Discinidæ									
Discina Dundriensis	Moore				+				
——— *orbicularis*	Moore			+					
Strophomenidæ									
Leptæna Bouchardii	Davidson			+					
——— *Davidsonii*	Deslongchamps			+					
——— *granulosa*	Davidson			+					
——— *liasiana*	Bouchard.........			+					
——— *Moorei*	Davidson			+					
——— *Pearcei (?)*	Davidson			+					
Rhynchonellidæ									
Rhynchonella Bouchardii	Davidson			+					
——— *coronata (?)*	Moore			+					
——— *L[illegible]pensis*..	Moore				+				
——— *Moorei*	Davidson			+					
——— *sub-concinna*	Davidson		+						
——— *sub-tetrahedra* ..	Davidson		+						
Spiriferidæ									
Spirifera Ilminsterensis.........	Davidson			+					
——— *minuta*	Moore				+				
——— *Munsteri*	Davidson		+	+					
——— *oolitica*	Moore				+				
Terebratulidæ									
Terebratula Edwardsii	Davidson		+						
——— *globulina*	Davidson ...			+					
——— *Lycetti*	Davidson......			+					
——— *[illegible] (?)*	Moore						+		
——— *Moorei*	Davidson......		+						
——— *pygmæa*	Davidson			+					
——— *sub-punctata*	Davidson		+						
Terebratella radiata	Moore				+		+		
Terebratella Buckmani	Woodward ..						+		
——— *furcata*	Sow. and Moore						+		

(Bradford Clay column:) Most of the species found in the Great Oolite occur also in this zone.



TABULAR VIEW OF ADDITIONS TO BRITISH SECONDARY BRACHIOPODA DISCOVERED BY THE AUTHOR, WITH THEIR STRATIGRAPHICAL DISTRIBUTION, *(Continued.)*

Genera and Species:	Authority.	Lower Lias.	Middle Lias.	Upper Lias.	Inferior Oolite.	Fuller's Earth.	Great Oolite.	Bradford Clay.	Coral Rag.
Thecididæ									
Thecideum Bouchardii	Davidson.........		+	+	+				
——— *Deslongchampsii* ...	Davidson.........				+				
——— *Dicksonii*	Moore				+				
——— *duplicatum*	Moore				+				
——— *Forbesii*	Moore				+				
——— *granulosum*	Moore				+				
——— *Moorei*...	Davidson.........		+						
——— *ornatum*	Moore								+
——— *pygmæum*	Moore								+
——— *rusticum*...............	Moore			+					
——— *serratum*	Moore				+				
——— *septatum*	Moore				+				
——— *triangularis*	D'Orbigny	+	+	+	+	+	+	+	+
Zellania Davidsonii	Moore				+				
——— *globata*	Moore						+	+	+
——— *Laboucherei*	Moore				+				
——— *liasiana*	Moore			+					
——— *oolitica*	Moore				+				

EXPLANATION OF PLATE II.

Fig. 1. *Thecideum ornatum*, Moore. Exterior of perfect shell enlarged.
2. ——— ———. Interior of ventral valve, showing raised oval processes and septum.
3. ——— ———. Interior of small valve, much enlarged, showing the serrated septum and the delicate loop for the support of the branchial membrane.

Fig. 4. *Thecideum pygmæum*, Moore. Perfect shell much enlarged.
5. ——— ———. Interior of ventral valve.
6. ——— ———. Interior of dorsal valve, ditto.
7. ——— ———. Profile of perfect shell.
8. *Crania canalis*, Moore. Exterior of upper valve somewhat enlarged.
9. ——— ———. Young shell before possessing spinose expansions.
10. ——— ———. Enlarged restoration of interior of valve, showing the muscular impressions and the grooved form of the spines.
11. *Crania Saundersii*, Moore. Exterior of shell.
12. ——— ———. Interior of valve, giving the position and form of the muscular impressions.
13. *Crania Ponsortii* (?), Eug. Deslongchamps. Exterior of valve.
14. ——— ———. Interior of ditto.
15. *Discina Dundriensis*, Moore. Enlarged exterior of shell.
16. ——— *orbicularis*, Moore. Exterior of valve enlarged.
17. ——— ———. Interior of ditto.
18. ——— ———. Block, with specimens of natural size.

19. *Spirifera* [illegible], Moore. Perfect enlarged exterior.
20. ——— ———. Exterior of the ventral valve.
21. *Terebratula* (?) *minuta*, Moore. Perfect shell, enlarged exterior.
22. ——— ———. Interior of dorsal valve.
23. *Rhynchonella* (?) *coronata*, Moore. Enlarged dorsal aspect.
24. ——— ———. Interior, showing ventral aspect.
25. ——— ———. Exterior of ventral valve.

FOREIGN CORRESPONDENCE.

Lunar relations of Earthquakes.

M. A. Perrey, in a paper read before the French Academy on the frequency of earthquakes during the latter half of the 18th century—relatively to the age of the moon, and of the frequency of the phenomenon at the time of the moon crossing the meridian—furnishes a series of facts worthy of the highest consideration. Referring to his previous labours on this subject, he points out that, in the present paper, in contradistinction to his former method, if an earthquake has taken place on the same lunar day, in different parts of the earth without the intermediate district being affected, that day is entered as many times as earthquakes have taken place. In this way he has found that from 1801 to 1850 the earth has trembled three thousand six hundred and fifty-five days, with a marked preponderance at the syzygies.

If the mean lunation of 29·53 days be divided into eight equal parts the earthquakes will not be found to distribute themselves equally, but will show a preponderence at the beginning, the middle, and the end—the curves representing which will take a wave-like form, with two maxima and two minima.

Uniting the numbers of the first and last eighths of the lunar month, the sum will express the monthly frequency at the new moon; the second and third combined give the frequency during the first quarter; the fourth and fifth at the full moon; while the sixth and seventh show the frequency at the last quarter.

Again combining the results for the two syzygies and the two quadratures, we find that from 1751 to 1800

	Shocks of Earthquakes.
At the Syzygies	1901·18
At the Quadratures.....	1753·82
Difference in favour of Syzygies...............	147·36

After some further references to his preceding memoirs, M. Perrey proceeds—"One is then justified in admitting that earthquakes are more frequent at the syzygies than at the quadratures; the conclusion we have arrived at from our researches of 1853 is now proved to be applicable to a whole century. But this law, true for a century and a half century, will it hold good for a quarter, or say a tenth, of a century?

"I have divided the latter half of the eighteenth century into two portions of twenty-five years each; and calculations similar to the above have led to similar results: so also for ten-yearly periods. I have also divided it into ten periods of five years: the numbers not being great in this case, the irregular and perturbating causes it might be easily imagined would regain their sway, and mask the differential action of a continuous influence. Nevertheless, in eight of these ten periods the preponderence is with the syzygies.

These results, however, of which the concordance is very striking and demonstrative of an influence connected with the movement of the moon in its orbit, are not the only ones to be mentioned. M. Perrey has fonnd that the numbers of times the days of perigee and apogee with the two days preceeding and following have been marked by shocks of earthquake, are as follows:—

	Days of shock.
Perigee	526
Apogee	465
Excess at perigee	60
Or, counting only the day before and after:—	
Perigee	313
Apogee	278
Excess at perigee	35

M. Perrey concludes by referring to journals kept at Monteleone, Messina, Calanzaro, and Scilla, at which places in every instance, the shocks felt with the moon on the meridian exceed those felt at other times.

This paper was followed by one by M. Gentili, "On the cause assigned to Earthquakes, founded on observations made at different times at the summit of the Soufrière, a volcanic mountain in Guadaloup."

Capillary Infiltration of Water in Rock-strata.

This journal was the first to call attention in this country to the important researches of M. Daubreé on the metamorphism and chemical conditions of roeks.

Another contribution to our science, under the title of "Experiments on the possibility of a capillary infiltration through porous materials, in spite of a strong counter-pressure of vapour," has been recently presented to the Académie des Sciences, by this eminent experimentalist.

"Every day," he says, "in the great phenomena which make manifest to us the internal activity of our globe, immense bodies of water, in the form of vapour, are disengaged.

"One naturally asks if the supply of this water is not kept up partially, at least, from the surface, and, if so, by what means?

"It is difficult to imagine this supply produced by a free circulation; for the way open to the descending water would form a means of escape which would naturally offer itself to the ascending vapour. Now the immense pressure of this vapour in the volcanic districts—a pressure great enough to force columns of lava, about three times denser than water, to vast heights above the sea-level—proves that these safety-valves do not exist.

"I have therefore been led to examine whether the water cannot penetrate into these deep and hot reservoirs, not by fissures as previously imagined, but in virtue of the porosity and capillarity of the intervening beds."

M. Daubrée then refers to the experiments carried on by M. Jamin, showing the influence of capillary attraction in changing the conditions of equilibrium between different pressures by means of a column of liquid, and points out that the geological problem requires a variation in the temperature not introduced by M. Jamin,—in fact the liquid in one part of the connecting column must be reduced to a state of vapour, in which, perhaps, it will be governed by different laws.

M. Daubrée then proceeds to describe his apparatus as follows:—

"I have therefore constructed an arrangement, of which the principal end is to join—by means of a partition of porous sandstone of a fine close grain—on one side a closed chamber, in which the pressure of the steam—one seven-eighth atmospheres, and on the other a space in direct communication with the external air, half filled with water, which soon was heated to the boiling point: in the latter chamber—of course, being open to the atmosphere—the ordinary pressure was not exceeded, although the thickness of the sandstone partition was but two centimètres. The result of the experiment proves that the water is not driven back by the counter-pressure of the vapour: the difference of the pressure on both sides of the partition does not prevent the liquid from penetrating from the region comparatively cold to the region comparatively hot, by a kind of capillary attraction; favoured also by the rapid evaporation going on in the latter."

M. Daubrée promises further experiments with a thicker partition, which will enable the vapour in the first chamber to be raised to a higher temperature.

The results he has already arrived at prove that capillary attraction, in addition to weight, can—in spite of very strong interior counter-pressure—force water to penetrate from the superficial and cold regions of the globe into the interior, where, by reason of high the temperature and pressure, it, in the shape of steam, is capable of producing great mechanical and chemical results.

"Do not the foregoing experiments," asks M. Daubrée, "also make us acquainted with the main-spring of volcanic action and of other phenomena generally attributed to the generation of vapour in the interior of the globe, as, for instance, earthquakes, the formation of hot springs, the filling up of metalliferous veins, as also the various cases of the metamorphism of rocks.

"Without excluding the original water, which,element like, is generally supposed to be incorporated with the interior melted masses—do not these experiments show that the infiltrations descending from the surface act in such a manner that the interior regions are continually being replenished and exhausted; the replenishment being effected in a way the most simple, though vastly different from the syphon and ordinary sources of supply.

"Thus a phenomenon, slow, continuous, and regular, becomes the cause of sudden and violent manifestations comparable to explosions and losses of equilibrium."

Note on the New Mineral Fournelite.

M. Ch. Mène, in order to establish the chemical formula of the mineral found by him near Beaujeu (Rhône), has made several analyses of specimens of different densities furnished him by the proprietor of the mines: the results fully confirm those previously arrived at in September last.

The average percentage of the components—leaving the quartz out of the question—is as follows:

Copper	32·0
Lead	12·0
Sulphur	23·0
Iron	3·0
Arsenic	8·0
Antimony	22·0
	100·0

Whence the following symbol is derived:—

$$3Cu^2 S + 3Sb^2 S^2 + Pb S. + Fe. Ar.$$

Chemical Characters of Combustible Minerals.

M. E. Fremy, who for a long time has been carrying on chemical investigations on the tissues of vegetables, has laid before the Academy of Sciences of Paris the results of his recent researches "On the Chemical Character of Combustible Minerals," in which he has also sought to inquire if the substances which compose them present any analogy with those which form the unaltered tissue of plants.

Admitting with other geologists that peat, lignite, coal, and anthracite have been formed under different circumstances, and belong to rocks of very different ages, he has endeavoured to trace in these varieties of combustibles, the degree of alteration of the organic tissue.

The study of the peat has presented really no new fact. Besides the unaltered elementary organs which are met with in such great quantities in the fibrous peat, he has found according to the state of alteration of the combustible, variable proportions of those brown compounds—neutral or acid, azotized or non-azotized—which are designated under the general title of *ulmic compounds*.

The presence of these bodies, which have been already studied by M. Payen, nevertheless goes to establish a very clear distinction between the peats and the unaltered organic tissues. The chemical examination of the lignites offers more interest.

In these researches distinction has been made between the lignites presenting still some woody structure, and those which offer the aspect and compactness of coal. The first constitute the xyloid lignite or fossil wood: the second form the compact or perfect lignite.

In respect to chemical characters, all the varieties of lignite may be placed in one or other of these classes.

Although the xyloid lignite may sometimes have the tenacity and the appearance of ordinary wood, he has recognized that in that combustible the woody tissue has experienced a great modification. It is reducible to a fine powder by trituration; and submitted to the action of a weak solution of potash it yields to that alkali a considerable quantity of ulmic acid.

The two following re-actions tend to establish a well-marked difference between the ordinary wood and xyloid lignite.

When the azotic acid reacts at a high temperature on the wood it dissolves a part only of the fibres and medullary rays, and leaves the cellular matter quite pure, which dissolves without coloration in concentrated sulphuric acid; and possesses all the properties that M. Payen has studied with so much precision.

Under the same circumstances the xyloid lignite is attacked with great energy and transformed into a yellow resin, soluble in alkalis and in an excess of azotic acid.

When wood and xyloid lignite are comparatively submitted to the action of hypochlorites very marked differences between these two substances are likewise established. The hypochlorites exercise upon the wood a reaction, which, perhaps, may be compared to that of the azotic acid; they dissove rapidly a part of the fibres and medullary rays, and leave the cellulose matter in a state of purity.

The xyloid lignite is attacked by the alkaline hypochlorites; is desolved nearly entirely by these reactives; and leaves only imponderable traces of fibre, and colourless medullary rays.

It follows from the preceeding facts, that when the woody tissues have arrived at that state of modification which constitutes the xyloid lignite, still preserving the appearance of wood, they have experienced in their substance a great modification, and contain then direct new principles, characterized by their complete solubility in azotic acid and the hypochlorites

After having determined the chemical characters of xyloid lignite, it was interesting to inquire if the compact lignite—which presented no longer the texture of the woody tissues, which is black and shining like coal, and which often offers such analogies with this latter substance as to put at fault the most experienced engineers—would preserve the chemical character of the xyloid lignite, or would ally itself with the coals.

In a geological point of view this comparative study of the xyloid lignite, compact lignite, and coal appears to possess a great importance. If there really existed a certain affinity between the state of alteration of the combustible minerals, and the age of the rocks containing them, one comprehends it would be of interest to geology to possess a chemical character—independently of those pointed out by M. Cordier—which would permit the exact appreciation of the degree of modification of the organic body, and the determination of the age of a rock by the state of alteration of the combustable mineral found in it.

M. Fremy has applied himself, then, to find a series of chemical reactions acting differently on the combustible minerals, and permitting him to arrange the series of their varieties according to their degrees of alteration, and the chemical characters they would thus present. The reagents he employed were potash, the hypochlorites, sulphuric acid, and nitric acid.

Having pointed out the difference between woody tissue and xyloid lignite, he goes on to show in what this latter differs from compact lignite, which having lost all trace of its original organization is only liable to be mistaken for certain varieties of coal.

The manner of burning, the reaction of the volatile products of combustion upon litmus, and the colour of the ashes form in themselves well-known distinctive characters, which chemical reagents enable us to judge of with the greatest exactness.

When, therefore, a compact lignite is submitted to the action of strong potash the solution sometimes turns brown, and a small quantity of ulmic acid is held in solution; but generally this is not the case, which fact immediately establishes a distinction between compact and xyloid lignite.

M. Fremy is of opinion that the lignites which resists the action of potash are those nearest the coal-measures.

The compact lignites, which in their brilliancy and blackness resemble coal, are entirely dissolved in the alkaline hypochlorites, and are immediately acted upon by nitric acid, producing the yellow resin before mentioned.

These characters, then, render it easy to distinguish between lignite and coal, as this latter mineral is *not* dissolved by the hypochlorites, and is only slowly acted upon by nitric acid. On the former of these tests M. Fremy lays great stress.

Coal and anthracite, although resisting alkaline solutions and hypochlorites, dissolve readily and completely in a mixture of concentrated sulphuric and nitric acids: the liquid becoming of a dark brown colour, and holding in solution an ulmic compound, which is easily deposited by the addition of water.

M. Fremy states, parenthetically, that in connection with this subject he has exposed woody tissue to a temperature of two hundred degrees (Cen.), for several days, and has noticed several modifications successively take place, producing substances quite comparable to those found in the lignites—the first changes resembling the xyloid; the latter the compact lignites—resisting the alkalis, and yielding readily to the hypochlorites.

M. Fremy then sums up the results of his observation as follows:

1. The chemical characters of the combustible minerals subjected to the reagents pointed out are effaced by age; and the organic matter resembles graphite the more as the rock from which it is taken is older. An exception, however, must be made in the altered rocks. This result is entirely in accordance with the observations of the celebrated Regnault upon the subject.

2. The first degree of alteration of woody tissue, represented by peat, is characterized by the presence of ulmic acid, and also woody fibres and the cells of the medullary rays, which can be purified and extracted in great quantity by means of azotic acid and the hypochlorites.

3. The second degree of modification corresponds to fossil wood or xyloid lignite, which is in part soluble like the preceding body in the alkalis; but its alteration is more marked, for it is dissolved almost entirely in nitric acid and the hypochlorites.

4. The third stage of alteration is represented by perfect lignite, which the reagents tell us already partakes of the nature of coal,—in consequence, therefore, the alkaline solutions generally do not act upon it, although it is completely soluble in the hypochlorites and nitric acid.

5. The fourth degree of modification corresponds to coal, which is insoluble in alkaline solution and the hypochlorites.

6. The fifth state of alteration is shown by anthracite—which evidently resembles graphite—resisting the reagents which acted upon the preceding combustibles, as we have seen, and being attacked but slowly by nitric acid.

From this it will be seen that the chemical reagents employed by M. Fremy confirm the classification of combustible minerals recognized by geologists.

In concluding M. Fremy expresses an opinion to the effect that the substances which we have been considering are far from being the only modifications which the organic matter undergoes in its changes to the combustible minerals: he thinks that there are intermediate transformations of the organic tissues, which correspond to the differences which are noticeable in the different kinds of coal and lignite.

The question whether the reagents are sensible enough to characterize these varieties in the different kinds of coal, or in the same bed even, M. Fremy proposes to examine in a future communication.

Palæontological Researches in Greece.

From a communication on the researches in Greece, by M. Albert Gaudry, we extract the following interesting remarks:—

M. Gaudry states that in superintending the excavations which the Academy had placed under his care, he was struck not only with the size of many of the quadrupeds disinterred at Pikerimi, but also with the numbers of the different animals which were found together. There were numerous remains of antilopes. The bones collected by him in 1855 and in 1860 attest the presence of more than a hundred and fifty of these ruminants. It is probable that formerly some of these species lived together in large herds, as in our own time. All the zoologists who have lately given themselves to the study of the antilopes have agreed to divide them into several genera. Mr. Gray, in his catalogue of the Mammals in the British Museum, admits nearly thirty-seven genera derived from the old genus "Antilope." Most of the fossil kinds found in Greece cannot be classed in any one of these divisions; and to conform to the modern nomenclature should be arranged in new groups. Nevertheless, to these groups M. Gaudry only gives the title of sub-genera; for antilopes form a tribe in which, with few exceptions, it is difficult to determine true genera—that is to say, groups which separate themselves one from the other by an *ensemble* of special characters. M. Gaudry exhibited a series of skulls of antilopes which he found at Pikerimi. One of them presenting a strange appearance, its horns being raised upon the front part which forms the protection of the orbits, the region situated behind the horns being very long and narrow, and the occipital crest very straight.

The animal to which such a skull belonged cannot be included in any of the sub-genera of antilopes known at present. M. Gaudry proposes to call it *Palæotragus Rouenii.* After having given the measures of the skull, he goes on to say "Seen from behind the fossil reminds us of the skull of a horse, by its very straight occiput rising in the centre; but in all the other characteristics it differs from it: it is a true Ruminant. By the lengthened and rectangular form of that part of the skull which extends behind the orbits, the Palæotragus resembles the Helladotherium; but it differs from it by its non-sloping occiput, by having horns, and the molars being more furrowed. The discovery of this gigantic Ruminant has been already announced to the academy.

The lengthening of the posterior part of the skull, the molars marked with deep furrows, and the want of the lacrymal cavity, admit of some affinity between the Greek fossil and the giraffe, did not the position and form of the horns establish a distinction between them. By its rather confined face, deprived of the lachrymal cavity, the Palæotragus resembles the goat; but differs from it in the form of the teeth and the posterior part of the skull. The spreading of its horns, and their implantation in the orbits, reminds one of certain kinds of stags, especially the muntjàc, differing from them in the persistency of its horns. Although the Palæotragus is very large, there are others found in Pikerimi much larger."

M. Gaudry showed two skulls which proved that in all probability the two species named by M. Wagner *Antilope speciosa*, and *A. Pallasii* were one and the same.

This new fossil reminds one, by its form, its proportions, and the position of the axes of the horns, of the sub-genus *Damalis* ot of Hamilton Smith, and even more of the sub-genus *Oryx* of de Blainville, in which, following Ogilby's example, he includes the sub-genus *Aigocerus* of Demarest, now called Hippotragus; but it differs from both in its dental system.

M. Gaudry has also discovered the bones of an antilope taller than any of those of which the skeletons are in the museum at Paris, even including the *Oreas canna*: he proposes to name this *Palæoryx*. A very similar skull, though much smaller, has also been found by him. Besides the difference in size, the horns are more massive in proportion to the size of the head, and flatter. This species he has named *Palæoryx parvidens*.

On the Substances Worked by the Primitive Inhabitants of Gaul.

M. Robert has presented to the Academy of Sciences a supplement to his geological researches on the substances, more particularly stones, worked by the primitive inhabitants of Gaul.

In his preceding memoir he had suggested that the enormous blocks of stone found suspended, as it were, in the centre of fluviatile deposits, could only have got there by means of icebergs at the time of the breaking up of the ice on the river which flowed through primitive France.

It supported of this opinion that all the Latin authors agree in stating that the climate was very cold at the time of the conquest, and that the rivers were often sufficiently frozen over to allow the Gauls to move easily from place to place, whence one can infer that when the thaws arrived, occasions were furnished to the liberated ice to carry boulders along with it.

As stated in that previous memoir, M. Robert affirms that the deposits along the rivers in which the Celtic remains have been found have been formed by the water which previously filled the valleys. He furthermore adds, that the great thickness of the beds of soil, which cover the Celtic remains, shows that a very long period has elapsed since their deposit.

M. Robert does not admit that the first men in Europe were contemporaneous with the great pachyderms, the elephant, mastodon, rhinoceros, &c. On the contrary, he considers that an enormous lapse of time separated their epochs; for the remains of those found with the Celts are very much rolled and worn, while the bones of the auroch, horse, &c., are with difficulty distinguished from those of the present day.

"It is probable," he continues, "that when the peoples of Asia emigrated westward on the look out for fertile countries, still retaining their fondness for stones, whether as a custom, a religion, or a sign, we know not, they established themselves naturally in the valleys, then deeper than at the present time, and watered by rivers which offered them, with resources of all kinds, a milder temperature than could be met with on the elevated plains. It is probable that oftentimes they were obliged to evacuate their habitations in consequence of considerable floods: hence the confusion of the remains so precipitately abandoned; flints, with rolled stones of every kind, and real fossil-remains washed from the real diluvium, mixed with the bones of the animals, domestic or savage, drowned in the inundations."

In the sand-pits at St. Acheul, near Amiens, hatchets have been found, which, though coarsely worked, appear to belong to two epochs; some formed out of chesnut-brown—almost yellow flint, and with very round edges, apparently coming from a long way off, being much water-worn; the others in bluish-black flint with white spots, more or less sharp, with very flat edges, do not appear to have been rolled at all. The angles in these last are as sharp as when they left the hand of the workman; and one would say they had been fashioned on the very spot in which they are found. In fact, it is very easy to find rolled flints from which precisely similar hatchets could be made.

M. Robert has in his possession the largest hatchet found in this locality; it is thirty centimètres long, and weighs one thousand eight hundred grammes, and has, evidently been made from one of the cylindrical flints which there abound.

Although the bed in which these celts have been found is forty mètres above the level of the Somme, the greatest resemblance exists between it and those at Prècy-sur-Oise, and near the Seine at Paris. Like these last the lower strata are composed of rolled stones, which contain in their cavities white sand and very delicate fresh-water shells (principally Lymnea), which would inevitably have been reduced to fragments in a strong current. The upper strata consists of a thick deposit of yellowish sand.

One finds also at St. Acheul boulders of sandstone, which, however, are smaller than those at Prècy on the Oise, which in their turn are smaller than those of the Paris basin. In fact, the size of these boulders is exactly proportional to the transporting force, whether ice or current.

The nature of these worked flints may throw some light on the localities in which they are found, where all other means fail us.

In the Commune of Gouvieux (Oise) there is an abrupt eminence, called Toutvoyes, where exists what is generally supposed to be a Roman camp. M. Robert attributes it to the Gauls, the first inhabitants; for on carefully examining the locality, which was admirably chosen as a strategical position, he found spread upon the limestone soil a considerable number of hatchets, arrow-heads, and darts, formed out of flints obtained from the neighbouring chalk, or the fluviatile deposits which envelope the foot of the hill, in all respects similar to the celts found at Meudon.

The only hatchet which did not belong to the locality was a milky white polished one, similar to those found at Brégy.

M. Robert continues:

"To strengthen my opinion that the deposits which line the valleys traversed by water-courses, have been formed by those water-courses, and consequently have nothing to do with the diluvium; the boulders, rolled pebbles, the sand, and even the mud, have been derived from the lands washed by the rivers and their feeders.

"I applied myself some time ago, before I studied these Celtic remains from a geological point of view, to the collection of the rocks and fossils to be found in the fluviatile deposits of the Paris basin. Without enumerating all, I may mention having collected the following:—

1. Representatives of almost all the rocks which enter into the composition of the Paris basin.

2. Rocks of La haute Bourgoagne, principally a reddish quartz-like porphyry, which is rather common, and granite rocks.

3. Nerinæ, Terebratulæ, Madrepores, &c., belonging to the secondary formations.

It is as well to remark that these objects have always been picked up along the rivers in going towards their heads, but never above the supposed *situs* before having been carried by the water. We have, therefore, strong presumptive evidence that these same water-courses have transported all the materials which enter into the composition of the fluviatile deposits in which the Celtic remains have been embedded.

Fossil Fuel at Chiriqui, in Veragua, in Grenada.

During the summer of 1859, the United States government sent to Chiriqui, in the hope to discover a favourable line for a railway across the isthmus, an expedition to which Dr. Evans was attached as geologist.

He discovered in the Eocene Tertiary formation of that country an extensive and thick deposit of lignite of excellent quality, and ex. tremely bituminous. M. Jules Marcou has referred the fossils of this deposit to the genera *Cardium*, *Cerithium*, *Arca*, *Natica*, *Mytilus*, and *Nucula*, which belong to the age of the "Calcaire grossière" of Paris,

The collective thickness of the beds of coal is nearly seventy-four feet, and six are so near each other as to form a mass thirty feet in thickness, capable of being worked by the same gallery. The localities were it is seen are Cultivation creek, Blanco river, Sheinshik creek, Pope's Island. There are numerous debris of plants in the clay. A microscopic examination of the coal shows that it is formed of cellulose plants, the structure of which may be seen both in the cinders and in thin slices of the coal.

What is very remarkable is, that these Tertiary coals are exactly like those of the coal-measures proper, whilst the fossil fuel of the same age found in Oregon and Washington is non-bituminous.

It would appear that we have in the coal of Chirigui, formed in the Tertiary clays under the tropics, a modern instance of the conditions in which the coal beds in the coal-measures have been produced, thence results the resemblance of these Tertiary coals with those of the coal-measures proper, which, beyond a doubt, were formed under a tropical temperature.

An interesting geological fact is that the coal-measures have not yet been traced in South America. All the beds there observed belong to the Tertiary epoch.

On a means of recognizing the Shores of Ancient Seas.

M. Marcel de Serres, in a recent letter on a means of recognizing the ancient shores of the seas of geological epochs, after referring to his studies on the boring-mollusca, points out a locality near St. Apolis, in the neighbourhood of Pézenas as very interesting. There the cretaceous rocks, which run parallel with and adjoin the Mediterranean, are full of thimble-shaped cavities, the work of these mollusca. On the north side of the mountain nothing of the kind is seen; the rocks thus perforated are not elevated above the level of the soil beyond the point at which they have been bored, and the miocene beds rest on them.

Knowing as we do that the boring-mollusca are to be found in the vicinity of the coast-line, are we not justified in looking upon this spot as an old sea-shore? M. Marcel proceeds:—

"I am now endeavouring, by the consideration of similar facts, to determine, by means of the rocks attacked by these animals, the localities which mark the extent of the ancient seas, and I believe I have succeeded in a locality now well known in a geological point of view—I mean the basin of Neffier. There the palæozoic beds are bounded on the south-east by the tertiary marine formations; these are composed in certain localities of masses of polyps of the genus Astrea, pierced by a great number of Modiolæ and Petricolæ, and others.

As these different species recede but little from the coast, and the polyps occupy the same position as they did in the same sea, they seem to represent its ancient margin; a fact confirmed by their position relatively to the Mediterranean, near which these beds are situated.

On the Tertiaries of Bigorre.

M. Leymerie has communicated to the French Academy a note on the Tertiaries of Bigorre, principally studied in the valley of the Adour. From this note, which is very interesting, we extract the following description of the locality mentioned:—

"The Tertiaries of Bigorre consist entirely, in the valley we have named, of a lacustrine deposit, formed at the foot of the Pyrenees after the last rising of the land; and do not offer at any point the smallest indication of an upheaving force.

"This deposit in the first instance formed a table-land extending from the foot of the mountains; but this has since been divided by the diluvium streams into strips, as it were, now found separated by the valley of the Adour, and numerous dales.

"In the region which occupies us in the present paper, the tertiaries follow the bend of the hill between Bagnères and Lonides, and an outlying prominence, whose elevation was too great for the tertiary waters to cover.

"For this reason, on either side of this hill, we see the tertiaries commence by two beds which cover and level the cretaceous schists and overlying beds, pierced and diversified by granite and ophites, which never, however, reach the surface.

"One of these beds begins at Bagnères, but only on the right side of the Adour, whence it extends to the east to join itself to the plain of Launemezan.

"The other commences not far from Lourdes, to the left of the valley of Adé. They leave between them the hill above mentioned, which is entirely uncovered by these deposits.

"A little to the north of Montgaillard (Vieille Ossun), near the plain of Tarles, one sees the outliers of the Pyrenees represented by the conglomerate of Palasson, dip under the tertiaries in such a manner that from this limit all the hills in the valley are composed of it."

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London,—March 6, 1861.

1. "On the Succession of Beds in the Hastings Sand in the Northern portion of the Wealden Area." By F. Drew, Esq., F.G.S., of the Geological Survey of Great Britain.

Having first referred to the division of the Wealden beds by former authors into the "Weald Clay," the "Hastings Sand," and the "Ashburnham Beds," and the subdivision of the "Hastings Sand" by Dr. Mantell into "Horsted Sands," "Tilgate Beds," and "Worth Sands," and having defined the district under notice as lying between and in the neighbourhood of the towns of Tenterden, Cranbrook, Tunbridge, Tunbridge Wells, East Grinstead, and Horsham, Mr. Drew proceeded to describe, first, the several beds in the meridian and vicinity of Tunbridge Wells. The Weald Clay is at least six hundred feet thick in this district, and is underlaid by sands and sandstones, termed by the author the "Tunbridge Wells Sand," on account of its being well exposed there. This subdivision is about one hundred and eighty feet thick, and was described in detail; an important feature being the "rock sand," or massive sandstone forming the picturesque natural rocks of that neighbourhood. The shales and clays underlying these sands form the "Wadhurst Clay" of the author, and are at places one hundred and sixty feet thick. This subdivision has yielded much ironstone in former times. It is underlaid by other sand and sandstones, more than two hundred and fifty feet thick, also yielding ironstone. These are termed "Ashdown Sand" by Mr. Drew, on account of their forming the heights of Ashdown Forest.

Eastward of the meridian of Tunbridge Wells Mr Drew has found the same sequence of beds, and he believes a similar succession to occur around Battle and Hastings. Westward of Tunbridge Wells, as far as East Grinstead the same beds occur, but beyond that the Weald Clay and Tunbridge Wells sand alone are exposed; and the latter is here divided into upper and lower beds by shale and clay (termed "Grinstead Clay" by the author), which thicken westward to fifty feet and more. It is the "Lower Tunbridge Wells Sand" that forms natural rocks near Grinstead. Near Horsham the Weald Clay contains, at about one hundred and twenty feet from its base, bands of stone known as the "Horsham Stone," used for roofing and paving.

The author then explained at large the grounds on which he proposed to replace Dr. Mantell's term "Horsted Sands" by "Upper Tunbridge Wells Sand," that of "Worth Sands," by "Lower Tunbridge Wells Sand," and that of "Tilgate Beds" by "Wadhurst Clay"; and his reason for proposing the name of "Ashdown" for the next lowest bed of the "Hastings Sand."

The paper concluded with a description of some of the chief lithological characters of the clays and sandstones of the Wealden area under notice.

2. "On the Permian Rocks of the South of Yorkshire; and on their Palæontological Relations." By J. W. Kirkby, Esq. Communicated by T. Davidson, Esq., F.G.S.

The author, after defining the area to be treated of, first noticed the results of the labours of former observers in this district; and then succinctly described the several strata, referring to Professor Sedgwick's Memoir on the Magnesian Limestone for descriptions of the physical geography, and very much of the lithological character of the country under notice. The strata treated of Mr. Kirkby recognizes (in descending order) as 1, the Bunter Schiefer, about fifty feet thick; 2, the Brotherton Beds, one hundred and fifty feet; 3, the small-grained Dolomite, two hundred and fifty feet; 4, the Lower Limestone, one hundred and fifty feet; 5, the Rothliegendes or Lower Red Sandstone, one hundred feet. These were then compared and co-ordinated with the Permian strata of Durham, where the three limestone members are thus represented:—1. The Upper Limestone by the Yellow, Concretionary, and Crystalline Limestone (two hundred and fifty feet). 2. The Middle Limestone by the Shell- and Cellular Limestone (two hundred feet) and 3. The Lower Limestone by the Compact Limestone (two hundred feet) and the Marl-slate (ten feet). The over- and under-lying sandstones being much alike as to thickness in the two areas.

After some remarks on the probable geographical conditions existing in the Permian epoch, the author proceeded to treat of the Permian fossils of South Yorkshire in detail. These belong to about thirty species, and are nearly all from the Lower Limestone; three species only occurring in the Brotherton beds. With three exceptions they occur also in the several limestones of Durham; five of them are found in the lower part of the red marls of Lancashire; and six of them are found at Cultra and Tullyconnel in Ireland. The distribution of the species in the several beds at different localities having been fully treated of, the Permian fossils of South Yorkshire were compared; first, with those of Durham; next, with those of Lancashire; and thirdly, with those of Ireland. Remarks on the distribution of the Permian Fauna in time concluded the paper.

1. "On a Collection of Fossil Plants from the Nagpur Territory, Central India." By Sir. C. Bunbury, Bart., F.R.S., F.G.S., &c.

The specimens examined by the author were collected by the Rev. Messrs. S. Hislop and R. Hunter, and presented to the Geological Society in 1854, and since. The vegetable remains described in this paper are.—1. *Glossopteris Browniana*, var. *Australasica*, Ad. Brong. Very few specimens from Bharatwádá, and at the foot of the Mahádewa Hills. *G. Browniana*, var. *Indica*, Ad. Brong. By much the most abundant plant in the collection, with many sub-varieties; specimens very fine, many of them in fructification. Silewádá. 2. *G. musæfolia*, sp. nov. Silewádá and Kampti. 3. *G. leptoneura*, sp. n. Kampti. 4. *G. stricta*, sp. n. Silewádá and Kampti. 5. *Pecopteris*, sp. somewhat resembling *P. Plukenetii*. Kampti. 6. *Cladophlebis* (?), Kampti. 7, *Tæniopteris, danæoides*, M'Clelland (?), Kampti. 8. *Filicites*: possibly a *Glossopteris*. Silewádá. 9. *Filicites*: possibly a *Glossopteris*. Kampti. 10. *Nœggerathia* (?). Bhratawádá. 11. *Phyllotheca Indica*, sp. n. Bharatwádá, Bokára, Kampti, Silewádá, and Barkoi. 12. *Vertebraria* (?). Different from the true *Vertebraria*, and probably *roots*. Tonkaheiri, Kampti, Barkoi, and Mahádewa Hills. 13. *Knorria* (?). Mangali. 14. *Stigmaria* (?): perhaps the rhizome of a fern. Mangali. 15. Part of a stem, somewhat Sigillarian in appearance. Silewáda. 16. Part of a large stem with a scar. Silewada. 17. *Fuceites* (?). Kampti. The fruits and seeds are reserved for further examination. On a general survey of all these plant-remains, the author for the present considers the *facies* of the fossil flora under notice to be Mesozoic rather than Palæozoic, but he regards the question as an open one, and requiring much further light for its perfect elucidation.

2. "On the Age of the Fossiliferous thin-bedded Sandstones and Coal-beds of the Province of Nagpur, Central India." By the Rev. Stephen Hislop. Communicated by the President.

The author first pointed out the places near the city of Nagpur where the *plant-bearing sandstone* has been best studied (Silewada, Kampti, Bokhara, Tondakheiri, &c.); also other places as far distant as twenty miles west, thirty-five miles north-east, and eighty-five miles south (Chanda. He next noticed the carbonaceous shales underlying thick sandstones, at the foot of the Mahadewa Hills, and the coal-seams of Barkoi, near Umret, eighty miles and more north-west of Nagpur; and pointed out their relationship to the plant-bearing sandstone near Nagpur, as shown by the *Glossopteris*, and other fossils found in each locality. Reference was then made to the author having previously correlated the above-mentioned sandstones, shales, and coal, with the coal-bearing-beds of Western Bengal, where the same group of fossil plants are found.

At Mangali, between fifty and sixty miles south of Nagpur, dark red sandstones are found, rich with *Estheria*, and containing remains of plants, Ganoid Fishes, and Reptiles (*Brachyops laticeps*, Owen). These beds Mr. Hislop thinks to be of the same age as those of Nagpur and Chanda. Still further south (one hundred and seventy miles from Nagpur), at Kota, there are (under thick sandstones) limestones and shales, containing fishes of the genera, *Æchmodus* and *Lepidotus*, Teleosaurian remains, Coprolites, fossil Insects, *Cypridæ*, and *Estheria*, with obscure plant-remains. These beds are also regarded by the author as equivalent in age to the plant-bearing sandstones of Nagpur; whilst the sandstones above them may be equal to the sandstone of the Mahadewas; and the red clay beneath them may be the same as that of Maledi, thirty miles off (to the north-east), where *Ceratodus* teeth and Coprolites have been found in abundance.

Whether any beds equivalent to the Rajmahal (upper Damuda) series of Western Bengal occur in the Nagpur district, the author is not quite certain

These are particularly characterized by the abundance of *Cycadaceæ*. They may perhaps be found near Kampti, not far from Nagpur.

Mr. Hislop then compared in detail, 1st, the fossil flora of the coal-fields of New South Wales with those of Central India; 2nd, the fossil plants of Western Bengal with that of Central India; and 3rd, the fossil fauna of these two regions; and came to the conclusion that, on the whole, they probably represent the Jurassic (or possibly the Triassic) period,—at all events some portion of the Lower Mesozoic epoch.

3. "On the Geological Age of the Coal-bearing Rocks of New South Wales." By the Rev. W. B. Clarke, F.G.S.

The author first referred to his report, in 1847, of the occurrence of *Lepidodendron, Sigillaria*, and *Stigmaria* in the coal-fields of Australia; and advanced proofs, derived from collections and publications both by himself and others, of the occurrence of *Lepidodendron* (*Pachyphlæus* (?), Gœppert) over a region extending from twenty-three degrees to thirty-seven degrees south lat., and at least one thousand miles long. After some observations on the association of Carboniferous and Devonian fossils with the coal-beds of Australia and Tasmania, Mr. Clarke stated that in 1859, at Stony Creek, near Maitland, Mr. B. Russell, having sunk two pits in search of coal, found four or five coal-seams lying between beds containing *Pachydomi, Spiriferi, Orthoceratites, Conulariæ*, &c.; and beneath them a shale containing *Næggerathia, Glossopteris, Cyclopteris*, &c. From this and other evidence the author is induced to believe that the beds are of palæozoic age, in spite of the "Jurassic" appearance of the plant-remains.

4. "On some Reptilian Remains from North-western Bengal." By Prof. T. H. Huxley, F.R.S., Sec. G.S.

Some bones, found by Mr. Blandford in the uppermost portion of the "Lower Damuda" group of strata in the Ranigunj coal-field, and forwarded to the author by Dr. Oldham, have proved to belong to Labyrinthodont Amphibia and Dicynodont Reptiles; hereby affording new and interesting links with the fossil fauna of the Karoo-beds of South Africa, and largely increasing the probability that the rocks in which they were found are of Triassic, or perhaps Permian, age.

April 10, 1861.

1. "On the Geology of the country between Lake Superior and the Pacific Ocean (between forty-eight and fifty-five degrees parallels of latitude), explored by the Government Exploring Expedition, under the command of Captain J. Palliser (1857—60)." By James Hector, M.D. Communicated by Sir R. I. Murchison, V.P.G.S.

The paper gave the geological results of three years' exploration of the British Territories in North America along the frontier-line of the United States, and westward from Lake Superior to the Pacific Ocean.

It began by showing that the central portion of North America is a great triangular plateau, bounded by the Rocky Mountains, Alleghanies, and Laurentian axis, stretching from Canada to the Arctic Ocean, and divided into two slopes by a watershed that nearly follows the political boundary-line, and throws the drainage to the Gulf of Mexico and the Arctic Ocean. The northern part of this plateau has a slope, from the Rocky Mountains to the eastern or Laurentian axis, of six feet in the mile, but is broken by steppes, which exhibit lines of ancient denudation at three different levels; the lowest is of freshwater origin; the next belongs to the Drift-deposits, and the highest is the great Prairie-level of undenuded Cretaceous strata. This plateau has once been complete to the eastern axis, but is now incomplete along its eastern edge, the soft strata having been removed in the region of Lake Winipeg.

The eastern axis sends off a spur that encircles the west shore of Lake

Superior, and is composed of metamorphic rocks and granite of the Laurentian series. To the west of this follows a belt where the floor of the plateau is exposed, consisting of Lower Silurian and Devonian rocks. On these rest Cretaceous strata, which prevail all the way to the Rocky Mountains, overlaid here and there by detached tertiary basins.

The Rocky Mountains are composed of Carboniferous and Devonian limestones, with massive quartzites and conglomerates, followed to the west by a granitic tract which occupies the bottom of the great valley between the Rocky and the Cascade Mountains. The Cascade chain is volcanic, but the volcanos are now inactive; to the west of it, along the Pacific coast, Cretaceous and Tertiary strata prevail. The description of these rocks was given with considerable detail on account of their containing a lignite, which for the first time has been determined to be of Cretaceous age. This lignite, which is of very superior quality, has been worked for some years past by the Hudson Bay Company, and is in great demand for the steam-navy of the Pacific station, and for the manufacture of gas. Extensive lignite-deposits in the Prairie were also alluded to; and, like that above mentioned, were considered to be of Cretaceous age; but, besides these, there are also lignites of the Tertiary period.

The general conclusion was that the existence of a supply of fuel in the Islands of Formosa and Japan, in Vancouver's Island, in the Cretaceous strata of the western shores of the Pacific, but principally within the British territory, and in the plains along the Saskatchewan, will exercise a most important influence in considering the practicability of a route to our eastern possessions through the Canadas, the Prairies, and British Columbia.

2. "On Elevations and Depressions of the Earth in North America." By Dr. A. Gesner, F.G.S.

After some observations on the differences between volcanic uplifts of the land and the slow upward and downward shiftings produced by changes in the position of great parallel areas during long periods of time, the author proceeds to enumerate evidences of local elevation and subsidence that he has observed along the coast from the northern part of Labrador to New Jersey.

In the south-eastern part of New Jersey, at Nantucket, Martha's Vineyard, and Portland, submergence of the land is proceeding, locally at the rate of probably four feet in sixty years. In New Brunswick, at St. John's the land has been elevated; at the Great Manan Island and the great Tantaman Marsh there has been subsidence. At Bathurst and on the opposite coast of Lower Canada the land seems to be rising. In Nova Scotia, near the Bay of Fundy and Mines Basin, there is subsidence; on the southern side, however, there are signs of elevation. The sea rapidly encroaches upon Louisberg in Cape Breton, and in Prince Edward's Island, also, at Cascumpec, submergence of the land is taking place.

Geologists' Association.—At the Monthly Meeting held at 5, Cavendish Square, on Monday, April 8th, the following papers were read:—

"On the Geology of the Isle of Portland," by W. Grey, Esq.

"On the Pearls of the Greensand Sea," } By Harry Seeley, Esq.
"On Fossil Pedicellaria," }

On Tuesday, the 9th of April, an Excursion was made to Reigate, under the guidance of the President, Prof. Tennant, and Mr. Bensted. The party proceeded to examine various sections showing the chalk, greensand, &c.; and then viewed a remarkable bed of Fuller's Earth, which is worked near that town.

Liverpool Geological Society, March 12th, 1861.

The following paper was read "On the Pleistocene formation of the district around Liverpool." By George H. Morton, Esq., F.G.S.

The author of the paper divided the superficial deposits of the district into two well-marked divisions, viz., strata of bluish clay, with submarine forest-beds, which repose on strata of sand, Boulder-clay, and gravel. If all the members of these two divisions were present in one section, they would occur in the following order.

Post-Glacial Deposits	1.	Drift sand
	2.	Peat bed
	3.	Bluish clay
	4.	Submarine Forest-bed
	5.	Bluish clay
	6.	Submarine Forest-bed
Glacial Deposits	7.	Upper Drift sand
	8.	Boulder clay
	9.	Lower Driftsand and gravel.

With the exception of the upper and lower Drift sands (Nos. 7 and 9), all these beds can be seen at Dove Point, on the Cheshire coast.

Beneath the Liverpool Custom-house, an old land surface, with the trunks of trees, exists about forty feet below the level of the ordinary spring tides. A similar bed occurs about two miles to the north, also on the Cheshire side of the Mersey, below the bed of Woollasey Pool.

The different degrees of subsidence in several localities, arises from the varying elevation of the original land above the sea. When the lowest beds were submerged the higher land-surfaces must have been above the level of the sea. The author concluded that the whole district had subsided about fifty feet, but that the greater part was prior to historical times.

Manchester Geological Society.—At the Ordinary Meeting on the 29th January, E. W. Binney, Esq., F.R.S., the Vice-President in the chair, there was a very full attendance of members and scientific visitors from the neighbourhood, great interest being manifested in Mr. Dickinson's paper "On the the Explosion at Hetton Colliery,"—in which that gentleman minutely detailed the circumstances of the melancholy explosion there on the 20th December previous. A discussion followed, in which the Chairman, Professor Roscoe, Mr. Booth, Professor Calvert, Mr. Knowles, Mr. Loveridge, and Mr. Dickinson took part.

The Chairman said that he considered it his duty to publicly contradict any erroneous statement which he saw in print respecting fire-damp. Now this invisible and intangible enemy is sufficiently dangerous to the coal-miner, often coming suddenly upon him, like a thief in the night, without any misleading as to where it is likely to be present or absent. In a work lately published in America—"A practical treatise on Coal, Petroleum, and other Distilled Oils, by Abraham Gesner, M.D., F.G.S.—published by Baillière—and having a considerable circulation in this country, at p. 14, is the following—"In mines of lignite and cannel coal, carbonic acid or *choke-damp* is almost the only gas present." Seams of cannel coal, from being open-jointed, no doubt do sooner allow the fire-damp to be drained from them than from seams of ordinary coal. However, we who are acquainted with the Wigan district, where more cannel is wrought than from any other mines in the world, on the one side, and those of Dunkinfield on the other, know well that fire-damp is sadly too prevalent in them, and accordingly thorough and efficient ventilation, aided by the use of safety-lamps, is or ought to be in use in cannel, as well as coal-mines, if explosions are to be prevented.

NOTES AND QUERIES.

Flint Implements in Yorkshire.—Sir,—I enclose you a few specimens which I picked up last summer, and which, until I read your article in "The Geologist," I regarded as arrow-heads; but as I find no exact representation of them either in your Diagram or "The Geologist," I am disposed to think otherwise. The flint curiosities I enclose for your inspection I found at Fimber, in the East Riding of Yorkshire; they are to be met with lying *in situ*, associated with other flints of our ploughed lands. They are easily recognized by the great contrast in appearance to the natural flints of the upper chalk of our wolds, which are nearly black, whereas the flints from our chalk strata or seams possess a colour much lighter, which you will see from the enclosed; besides, the black flints show sufficient evidence of having been chipped by hand for some use or other.

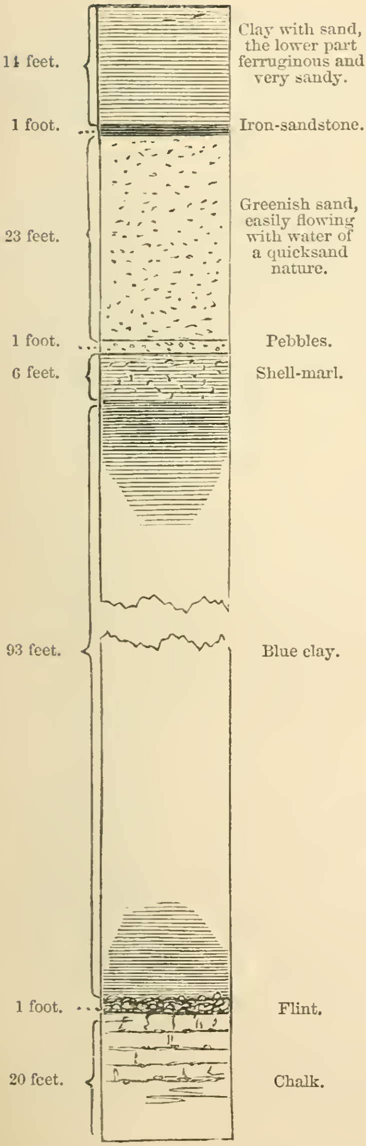
It is well to remark, where these black flints are found by me in this locality, numerous "dykes" are contiguous (which run in different directions), hence it is probable they may have been used as sling-stones by the warriors who cast up these lengthy and stupendous earthworks, if it can be proved that such missiles were used by the ancient Britons. Secondly, it may not be amiss to suggest Were these flints used by the aborigines in obtaining fire? I only throw out these suggestions, for the dark-coloured flints have peculiarities different from our own district flints, and therefore our conclusion is that they must have been imported from some other chalk-region, where the flints are of such darker hue, either as implements for war, or for producing a light by concussion. It is well to notice, too, that these black flints are picked up and considered as containing within themselves the most fire; we can well remember, in our time, these dark-flints being searched for to produce lights before the invention of the lucifer-matches. Again supposing these flints either to have been in use as "sling-stones" or fire-flints in the days of the ancient Britons, it is not at all improbable that they may be found some feet below the surface at Holderness, buried there by the sediments left by exceedingly high tides long previous to the great drainage being effected to keep the sea-water from inundating that district.

Last spring we took a trip to Springbank, a place near Beverley, to see a boring-operation going on for an artesian well, and whilst soliciting information on a few geological topics, we were told by one of the workmen that a few broken smoking-pipes were brought up by the steam boring apparatus, a specimen of which I have now in my possession. It has a thick head or bowl and stopper corresponding. A question might arise how have these pipes been embedded so deep in the earth!

In addition to the sling-stones or fire-flints, I have enclosed one which has a resemblance to an arrow-head, which I found in the same locality. These flints may have been used for both purposes, as their structure indicates.—Yours &c., Robt. Mortimer.

New Lingula Fossils.—Dear Sir,—I have just received several new species from the Lingula flags of North Wales, including a perfect specimen of *Agnostus pisiformis*. This fossil is the characteristic species of the alum-slates of Sweden, and supposed to be exclusively confined to them, and only very recently found in Great Britain; also two new species of *Asaphus*, *A. innolatus*, and *A. Stygius*, also *Theca operculata*, with operculum, which are very rare, and a new bivalve.

I have since heard of some other new species of shells from the Lingula-beds, but have not yet received any.—Yours faithfully, James R. Gregory.



Section of well at Stourmouth, 163 feet.

Tertiary Beds at Stourmouth, Kent.—Sir,—I enclose you a section of a well sunk at Stourmouth to the depth of 163 feet, and you will see that it is interesting as showing the depth of the Thanet sand in this direction. I have been engaged in collecting and making drawings of fossils found in the Beaksbourne cuttings, and should any of them be novel or interesting I shall be glad to let you figure them.

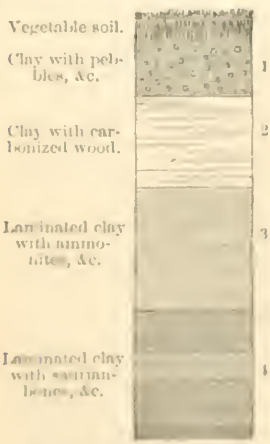
One part of the section I sent you deserved to have been more particularly described in my sections, viz., the drift-valley crossing the sections as shown in the Beaksbourne cutting; the peat there mentioned might, perhaps, have been more properly described as a dark loamy sand of organic structure and appearance.

This well at Stourmouth was sunk to the depth of about thirty feet by an ordinary well curb, and at the depth of fifteen feet from the surface an iron-sandstone was met with; below this a green-sand—very difficult to sink a well in, from its quicksand nature. Below this the well was continued by means of boring, a four-inch augur being used. At twenty-three feet pebbles were met with, small and rounded, of a greenish colour. Below this about six feet of shell-marl, the shell apparently exceedingly friable; then we came to a blue clay, varying rather in hardness, but throughout exceedingly tenaceous, so much so as to require much more than the usual appliances to bore through it, and at places very plastic, and sometimes presenting the appearance of septaria. At the depth of a hundred and thirty-nine feet flint was met with having the apparent flat tabulated form of flint in the chalk. This was shown from the difficulty we had in boring through it. After much labour with a large peeler on the boring-irons, a small hole was made which still resisted the passage of the augur, and kept turning the steel edge of it. Pieces of black flint were brought up with the augur, when we came to chalk, through which we pierced to the depth of twenty feet.

It is observable that the water which stood at the level of twenty-three feet from the surface, was not at all increased by penetrating this tenaceous clay into the chalk. Several wells have been bored in the neighbourhood of Minster through this strata, and water has risen to the surface; but in every case the depth through the chalk was greater, though the total depth less.—G. DOWKER, Stourmouth-house.

NOTES ON THE GEOLOGY OF THE COUNTRY ROUND NEWPORT PAGNALL.—SIR,—As I do not think much is known of the geology of this part of the country, I have made a brief summary of the chief features of the vicinity of Newport Pagnall, which I hope may be interesting. Just before reaching Wolverton (the nearest railway station to Newport), the train passes over a bridge built of forest marble, which is much quarried in the neighbourhood, being used both for road purposes and building-stone. The limestone abounds in shells and vegetable remains. Wolverton station is situated on the Oxford clay, in which, when the cuttings were being made, many fossils were found—the usual forms, such as ammonites, belemnites, gryphææ, ostreæ, &c., preponderating. The nacreous or pearly shell still remained entire on the ammonites, which were in a good state of preservation. In some places a thick layer of drift-clay covered the substratum; in this remains of ammonites and echinites, evidently from the chalk and greensand, were found.

If the road towards Newport Pagnall be taken from Wolverton, the village of Great Lindford will be passed, where, in digging a well, some workmen found the bones of plesiosauri. But all around the town of Newport Pagnall itself, the Oxford clay is greatly developed, and a great many clay-pits have been dug in the brickfields; in these the vertebræ and other bones, teeth, &c., of saurians, and the palatal-teeth of cartilaginous fishes are frequently found, with ammonites, belemnites, trigoniæ, and many bivalve shells; also the remains of coniferous trees and carbonized wood. The following is a section of one of the most productive clay-pits near Newport Pagnall.



Section of clay pit, Newport Pagnall.

No. 1 is a layer of light-brown clay, with flints and fragments of a concretionary limestone, in which I have occasionally found fossils, such as portions of *Ammonites Calloviensis*, alariæ, &c., which are characteristic of the Kelloway rock. No bones are found at a less depth than twelve or fourteen feet from the surface, that is to say only in the clay marked 4. The laminated clays 3 and 4 abound in ammonites compressed between the layers. Septaria are sometimes found in the clay, and abundance of selenite and iron-pyrites, from the decomposition of which the crystalized sulphate of lime has doubtless proceeded by the action of the liberated sulphuric acid or the calcareous particles of the clay.

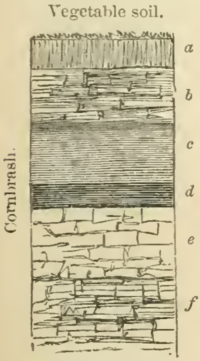
From Newport Pagnall the Oxford clay takes a north-west direction towards Olney, and the borders of Bedfordshire; but its course is much concealed by beds of alluvial gravel of great thickness, which extend over a large tract of country. This gravel is largely employed for mending the roads, consequently there are several pits dug. It abounds in fossils (chiefly oolitic). I have also found many pebbles of sandstone, basalt, greenstone, jasper, also flints and nodules of chalk, crystals of quartz, and carbonate of lime. The fossils which I have most plentifully found were *Gryphea incurva* from the Lias, ostreæ, belemnites, ammonites (scarcely ever entire), terebratulæ, serpulæ (three different species very abundant), choanites, and sponges from the chalk; echinites, portions of the stems of encrinites, and pentacrinites, and many shells from the Lias and Oolite*. In some of the pits there are no fossils at all, the gravel consisting merely of an aggregate of flints and pebbles, with a ferruginous yellow sand.

The scenery of this part of the country around which the Oxford clay is developed, is as uninteresting and devoid of beauty as can well be imagined, the only variation to the low flat fields being the distant view of the Bedford hills. A long and dreary valley, through which the river Ouse flows, extends several miles up the country, from Gayhurst to Olney. But on the other side the limestones of the Lower Oolites break into gentle undulations and hills; in some places the scenery, for a woodland country, is quite picturesque. I have before mentioned that forest-marble was much quarried in the neighbourhood of Wolverton; it takes the place of the Cornbrash of the south of England, making its appearance just below the Oxford clay; it is usually of a blue-grey colour, very hard, and sometimes finely laminated; but the fossils, in which it abounds, are difficult of extraction, owing to the indurated character of the stone. Trigoniæ, terebratulæ, the cones and leaves of coniferous trees, are particularly abundant.

The forest-marble extends from near Lethbury to Gayhurst, near which village we observe the Cornbrash succeeding the Forest-marble. Good sections of this limestone are exposed in some of the quarries.

There is a small stone-pit on the left-hand side of the road, about a quarter of a mile from the village of Gayhurst, in which, besides an abundance of the usual mollusca of the Cornbrash, I have found good specimens of Echinoderms, principally *Clypeus sinuatus*, *Nucleolites clunicularis*, *N. orbicularis*, and several species of Cidaridæ; also palatal teeth of *Strophodus magnus*, and traces of fossil wood.

The following sketch will serve to illustrate my remarks on the section displayed in this quarry.



Section of Stone-pit at Gayhurst.

b is a finely laminated fissile limestone, called by the quarrymen "pendle;" it naturally splits into thin slaty plate-like leaves, as the Stonesfield slate; but few organic remains are found in it, excepting now and then a few Trigoniæ. *c* is a layer of light-coloured clay, abounding in Terebratulæ, Isocardiæ, with many other shells and echinites. This is but three feet thick, and passes into the limestone *e*, through the medium of an indurated clay marked *d*, which is also very shelly.

The limestone *e* is much used both for road and building-purposes, but it is comparatively sterile of fossil remains. In the lowest rock, which is a sandy freestone, *Clypeus sinuatus*, *Clunicularis*, *Cidaris*, &c.. abound. But few shells are found entire, as they are difficult of extraction, owing to the indurated character of the stone. The Cornbrash extends in a north-west direction, and is quarried for building stone all around the town of Olney.

The Inferior Oolite next makes its appearance, and is observed near Eckly,

* The Belemnites are sometimes collected by the villagers, who consider them, when pounded, an excellent cure for rheumatism.

about a mile and a quarter north-east of the village of Stoke Goddington, forming a ridge of high ground extending onwards towards Northamptonshire, and having a gentle dip towards the north-west. There are many quarries in the neighbourhood, where the stone is found of a rubbly oolitic character, very shelly, and in some places merely an aggregate of Terebratulæ, and other shells cemented by a ferruginous sandy limestone. The following is a list of the most characteristic fossils which I have as yet found in these beds of Inferior Oolite, *Terebratula maxillata*, *T. bullata*, *Rhynchonella subtetrahedra*, *Modiola plinaba*, *M. cuneata*, *Pholadomya Murchisonii*, *P. lyrata*, *Gervillia lanceolata*,* *Isocardia minima*, *I. concentrica*, *Ostrea gregaria*, *O. acuminata*, *Cardium globosum*, *Pecten globosum*, *Lima*, &c., &c.

Most of the shells are filled with crystals of carbonate of lime; they are easily detached, and in good preservation. We have now crossed the boundaries of Buckinghamshire, and are in the county of Northamptonshire. The country is woodland, and in some places very picturesque. On the west there extends a large wood called "Salcey Forest." At the entrance of this wood there are quarries which once supplied the whole of the surrounding country with "metal" for the roads. The limestone apparently belongs to the upper bed of the Great Oolite; but on account of its exceeding barrenness in fossils it is difficult to determine its exact geological position. The same stone is found at Hantwell, Hanslope, and near Castle-Thorpe, succeeding the Forest-marble. The only fossils that have been found in these sterile beds are oysters, a few Terebratulæ, two or three Echinites, and slight traces of vegetable-remains. It is remarkable (but I believe frequently the case in the "great oolite") that although the stone seems almost wholly composed of comminuted and broken fragments of shells, yet few entire ones are here found.

But to revert to the Inferior Oolite, by far the most interesting formation of this neighbourhood. We find it again at the village of Piddington, overlying the Lias of Northamptonshire; a very characteristic shell here is *Pholadomya lyrata*. It becomes very ferruginous in places, being of that peculiar colour always indicative of oxide of iron. The top beds on account of their rubbly character are of little or no value as building-stone, the only use to which they can be put is that of mending the roads; but underneath the beds a much harder and more indurated stone is found. This consists principally of Terebratulæ, with a great deal of spar or crystallized carbonate of lime. This limestone becomes very useful for building-stone. The order of the succession of the layers in most of the quarries is as follows:—

1st. Soil.

2nd. A shell bed, consisting of various shells in an argillaceous and in some places a rubbly matrix.

3rd. Soft gritty limestone, with an abundance of shells, &c.

4th. Sandy limestone, with few fossils.

5th. Lower beds, with crystallized carbonate of lime, as above described.

I regret that my limits will not allow of any further particulars concerning the geology of this part of England. I am also sorry that I cannot touch upon the Liassic strata, which succeeds the Inferior Oolite. But I trust that it will not be imagined that I have nearly exhausted the subject; while I hope that this short and rather cursory sketch may induce others to visit our rather out-of-the-way quarries; and although they may not be so interesting as those of the South of England or of Yorkshire, in point either of the variety or quantity of their organic remains, there is still a charm in novelty.—J. H. Macalister, Stoke Goldington, Bucks.

* This is a very characteristic shell.

REMAINS OF AMERICAN "MISSOURIUM" ASSOCIATED WITH FLINT IMPLEMENTS.—DEAR SIR,—If you have not seen the enclosed "Description of the Missourium, or Missouri Leviathan, together with its supposed Habits and Indian Traditions," by Albert Koch (London, E. Fisher, 1841), it will perhaps interest you, as bearing upon the flint-implement question. You will find the notice of flints at pages 22-24. The part of the pamphlet about the "Leviathan" is purely a myth, or a puzzle, which any one may accept or reject as he pleases. The account given by Mr. Kock is as follows :—

"This gigantic skeleton measures thirty feet in length and fifteen in height; the head measures, from the tip of the nose to the spine of the neck, six feet; from one zygomatic arch to the other, four feet; from the lower edge of the upper lip to the first edge of the front tooth, twenty inches; from the front point of the lower jaw to the first edge of the front tooth, eight inches; from the edge of the upper lip, measuring along the roof of the mouth to the socket of the eye, three feet; from thence to where the atlas joins the head, ten and a-half inches. The whole number of teeth is eight—that is, four upper and four lower, not including the two tusks. The two upper fore-teeth are four inches broad and four and a-half inches in length, and are situated in the head in such a manner that they slant towards the roof of the mouth, insomuch that their outer edge is one and a-quarter inch higher than their inside edge. The back teeth in the upper jaw are seven inches in length, and where they unite with the front teeth, they are like those four inches broad, and from thence run narrower back until they end almost in a point (p. 7). * * * The bones were found by me near the shores of the river La Pomme de Terre, a tributary of the Osage river, in Benton county, in the state of Missouri, latitude forty and longitude eighteen. There is every reason to believe that the Pomme de Terre, at some former period, was a large and magnificent stream, from one-half to three-fourths of a mile in breadth, and that its waters washed the high rocky bluffs on either side where the marks of the rolling surges are now perfectly plain: they present a similar appearance to that of the Missouri and Mississippi. It appears, from the different strata, that since the Missourium existed, six or seven different changes have taken place here, by which the original bed of the Pomme de Terre was filled with as many different strata, which are as follows:—The original stratum on which this former river flowed at the time it was inhabited by the Missourium, and up to the time of its destruction, consisted of quicksand: on the surface of its stratum, and partly mingled with it, was the deposit of the before-described skeleton. The next is a stratum from three to four feet in thickness, consisting of a brown alluvial soil: in this all the remainder of the skeleton was contained, and covered by it. This stratum was mixed with a great quantity of vegetable matter, and most of this is in a wonderful state of preservation; but what is still more surprising, all the vegetable remains are of a tropical or very low southern production. They consisted of large quantities of cypress burs, wood and bark; a great deal of tropical cane and tropical swamp moss; several stumps of trees, if not logwood, yet bearing a very close resemblance to it; even the greater part of a flower of the Strelitzia class, which, when destroyed, was not full blown, was discovered embedded in this layer; also, several stems of palmetto leaf, one possessing all the fibres perfect, or nearly so. To those who are not acquainted with the nature of this plant, it is well to remark that it is not found at present farther north than the northern parts of Louisiana. The time when the revolution of the earth took place, during which this before-described animal lost its life, was between the 15th of September and 20th of October, which is proven by the fact just mentioned of the cypress burs being found; from which circumstance it might be readily inferred that they had been torn by force from their parent stem before they had arrived at perfection, and were involved in one common ruin with the trees which bore them, these having been torn up by the roots, and twisted and split into a thousand pieces, apparently by lightning, combined with a tremendous tempest or tornado. There was no sign or indication of any very large trees, the cypresses that were discovered being the largest that were growing here at the time. Through this stratum ran several veins of iron-ore—sufficient evidence of the antiquity of this deposit. Immediately over this was one of blue clay, three feet in thickness; the next was one of gravel from nine to eighteen inches in thickness, so hard compressed together that it resembled pudding-stone; the next was a layer of light blue clay, from three to four feet in thickness; on this was another stratum of gravel, of the same thickness and appearance as the one first mentioned; this was succeeded by a layer of yellowish clay, from two to three feet in thickness; over this, a third layer of gravel, of the same appearance and thickness; and, at last, the present surface, consisting of a brownish clay, mingled with a few pebbles, and covered with large oak, maple, and elm trees, which were, as near as I could ascertain, from eighty to a hundred years old. In the centre of the above-mentioned deposit was a large spring which appeared to rise from the very bowels of the earth, as it was never affected by the severest rain, nor did it become lower by the longest drought. About two hundred yards from said deposit stands a singularly formed rock, which not only bears the appearance, but may be considered as a monument of great antiquity, formed by nature, against whose rough and rugged sides can be distinctly traced, in deep and furrowed lines, the former course of angry waters; yet its summit is full thirty feet above the present level of the Pomme de Terre. The rock has the appearance of a pillar, on whose top rests a table rock far projecting over on every side; from the base of the pillar to the lower edge of the table is thirty feet, and from the base down to the deposit of the bones is sixteen feet making, from the stratum on which the bones were deposited to the edge of the table, forty-six feet. By a minute and close examination, I found that the formation of the said rock, as it now appears, was produced by the long action of the river against and around it; and had the river continued to act with the same force for one or two hundred years longer, the pillar would have been so far worn away, that the table must have fallen. It now stands as an indisputable witness, that the water, at the time these animals existed, was at least forty-six feet in depth. It is perfectly true that we cannot with any degree of certainty depend on Indian traditions; but it is equally true that generally these traditions are founded on events which have actually transpired, and according to their importance in relation to the welfare of the aborigines among whom they occurred, and in absence of any better method of perpetuating, are transmitted with great care in their legends from generation to generation; but in the course of time, as might reasonably be expected, these traditions lose much in correctness and minuteness of detail, owing to the circumstances, more or less, in which the tribes have been placed. As I am constrained to confine my remarks within very circumscribed limits, I will only relate one of the traditions having reference to the existence of the before-described animal; this one, however, led principally to its discovery. At the time when the first white settlers emigrated to the Osage country (as this section of territory is usually called), it was inhabited by the Osage Indians, and the river by which it is watered was called the Big Bone river, owing to a tradition preserved by them, which they stated as follows:—There was a time when the Indians paddled their canoes over the now extensive prairies of Missouri, and encamped or hunted on the bluffs. (These bluffs vary from fifty to four hundred feet in perpendicular height.) That at a certain period many large and monstrous animals came from the eastward, along and up the Mississippi and Missouri rivers; upon which the animals that had previously occupied the country became very angry, and at last so enraged and infuriated, by reason of these intrusions, that the red man durst not venture out to hunt any more, and was consequently reduced to great distress. At this time a large number of these huge monsters assembled here, when a terrible battle ensued, in which many on both sides were killed, and the remainder resumed their march towards the setting sun. Near the bluffs, which are at present known by the name of the Rocky Ridge, one of the greatest of these battles was fought. Immediately after the battle, the Indians gathered together many of the slaughtered animals, and offered them on the spot as a burnt sacrifice to the Great Spirit; the remainder were buried by the Great Spirit himself in the before-mentioned Pomme de Terre, which from this time took the name of the Big Bone river, as well as the Osage, of which the Pomme de Terre is a branch. From this time the Indians brought their yearly sacrifice to this place, and offered it up to the Great Spirit as a thank offering for their timely deliverance; and more latterly they have offered their sacrifice on the table-rock previously mentioned, which was held in great veneration, and considered holy ground. This ceremony was kept up with the utmost rigidity until one of the white emigrants settled in the valley at the foot of the rock, with the intention of making himself and family a permanent residence on this fertile spot: but he did not long enjoy this beautiful situation, for on the return of the Indians to offer their wonted sacrifice, they beheld with indignation and astonishment the intrusion of this venturesome settler on their sacred ground. Soon the council fire was kindled, when the Indians gave their accustomed murmur of dissatisfaction, and immediately the white man was obliged to leave, without the least preliminary ceremony. Some time after this, on becoming better acquainted with his red neighbours, and having through much perseverance gained their good opinion, after much reluctance on their part, and explanations and assurances that he would not infringe on their sacred privileges, and would only raise corn and potatos for his family, he was once more permitted to settle on this sacred spot, of which he retained peaceable possession until the return of some old chiefs, who had been for a long time absent. They in turn were exasperated to madness on seeing the violation of the sacred ground of their forefathers by the encroachment of the white man, and again the poor farmer was obliged to leave. From that time this spot remained in the hands of the Indians, and no entreaty or allurement could be held out to induce them to resign it, until they were removed by the government; it then for the third time fell into the hands of the original settler, who joyfully took possession of the place he had so long desired to make his home. After a while other settlers arrived, and as the want of a mill for grinding their different kinds of grain began to be felt, each family having hitherto been obliged, in order to obtain a supply of meal, to resort to the laborious process of pounding their corn in mortars, the old farmer resolved on building a tub-mill for the accommodation of himself and his neighbours. In order to procure the necessary water power, the aid of the before-mentioned spring was brought into requisition; and in making the necessary excavation, the labourers found several bones of young mastodons, which excited their curiosity and astonishment; but they suspended their labour on ascertaining that the force of the said spring was not sufficient for their purpose. Soon after this the place was sold, and the excitement about the bones and the Indians was forgotten until the summer of 1839, at which time a young man, who was employed to clean the said spring, found the tooth of a mastodon during his labour, which occurrence reminded several of the old settlers of the former transactions and traditions, and a narration of these induced a few persons residing in that vicinity, out of mere curiosity, to make further examination as to what was contained in the spring. They succeeded in finding several bones and teeth; but the mud and water accumulated so fast, they soon became discouraged with the difficulties attending the search, and gave it over. Some of these facts came to my knowledge in March, 1840, on my return to St. Louis from an excursion to the south-western part of the country, when I immediately repaired to the spot, and found the facts as I have here stated. * * * It is well known by all persons acquainted with geology, that is admitted as a fact, that the mastodons, together with the generality of antediluvian animals, existed and became extinct previous to the creation of the race of men; which supposition was founded on the fact that no evidence of human existence could be traced back to, or found with, those antediluvian animals. The positive cause of this I do not know. My opinion, however, is that this want of evidence of a former human race is, that those relics of the ancient animal world generally have been found accidentally by persons who were not aware of the importance of a minute and critical examination of the deposits disinterred by them, and therefore the scientific observer was deprived, no doubt, often of the facts necessary to be known in order to form correct opinions on this subject. In view of this I deem it my duty to lay before the world what facts I have been able to gather on this interesting subject, which will be strong evidence in favour of my belief, that there was a human race existing contemporary with those animals. These facts are as follows:—In October, 1838, I disinterred the remains of an animal which had clawed feet, and was of the size of an elephant. This deposit was in Gasconade county, Missouri, on the shores of the Burbois river. The principal part of this animal had been consumed by fire, which fire evidently had not been produced by a volcanic eruption, but had been formed and kindled mechanically by human hands, as it appeared, for the purpose of destroying the before-mentioned animal, which had been mired here and was unable to extricate itself. The particulars of the transaction are as follows. A farmer in Gasconade county, Missouri, perceived for some time a disagreeable taste in the water which he had used for his household. The water was taken out of a clear spring, situated in what is usually called a bottom, near his house. For the purpose of remedying this evil, he dug around and into the spring, thus to be enabled to enclose it afterwards as a well. By doing so, he found several bones belonging to an animal of an unusually large size. Some were whole, and some in fragments. Also, at the same time, he found a stone knife and an Indian axe. This circumstance created some excitement in the neighbourhood; and these transactions were mentioned to me some time afterwards by a Mr. Wash, who lived in the vicinity. On hearing this, I immediately made arrangements to proceed to the place. On my arrival there, in October, 1838, I found the prospects rather dull, as the bones which had been dug out of the spring were principally destroyed. They had been removed from their place of embedment without the least care, and were, of course, more or less broken; then exposed to the air without any kind of preservation being applied to them; and eventually what few remained tolerably whole, were broken by their curious visitors, to ascertain if they contained marrow; until the few remaining fragments were collected together by an intelligent gentleman, by the name of Bailey, residing in the neighbourhood, who presented them to me, and assisted me in my farther researches. I found, nine feet beneath the surface, a layer of ashes from six to twelve inches in thickness, mingled with charcoal, large pieces of wood partly burned, together with Indian implements of war, as stone arrow-heads tomahawks, &c, &c. Also more than one hundred and fifty pieces of rocks varying from three to twenty-five pounds in weight, which must have been carried here from the rocky shores of the Burbois river, a distance of three hundred yards; as there was no rock, stones, or even gravel near to be found, and as those pieces of rocks taken out of the ashes were precisely the same as that found on the river, which is a species of limestone; these had been thrown evidently with the intention of striking the animal. I found the fore- and hind-foot standing in a perpendicular position; and likewise the full length of the leg below the layer of ashes, so deep in the mud and water that the fire had no effect on them. The fore-foot of the animal consists of four toes and a thumb; each toe has five joints, each last joint was armed with a claw, or long nail. The thumb has two joints; the crown of the foot is composed of four bones, joined together, and each connected to a toe. On the top of this is a thin round bone, connecting them with the shin bone. The construction of this foot shows that it posssessed much power in grasping and holding objects. The hind-foot is smaller, and has also four toes, with five joints, but has no thumb. The crown is entirely different in construction from that of the fore-foot. A few of the teeth appeared to have been broken out by the force of the rocks thrown at the head or the animal, and were carried some little distance; so that they escaped in a measure the violence of the fire, and have all the appearance of those of a carnivorous animal. The second trace of human existence with these animals, I found during the excavation of the Missouri Leviathan. There was embedded immediately under the femur or hind-leg bone of this animal an arrow-head of rose-coloured flint, resembling those used by the American Indians, but of a larger size. This was the only arrow-head immediately with the skeleton; but in the same strata, at a distance of five or six feet, in a horizontal direction, four more arrow-heads were found; three of these were of the same formation as the preceding; the fourth was of a very rude workmanship. One of the last-mentioned three was of agate, the others of blue flint. These arrow-heads are indisputably the work of human hands. I examined the deposit in which they were embedded, and raised them out of their embedment with my own hands (p. 21-24)."

I have visited a drift-bed at Aylesford, but have not succeeded in getting any flint implements, excepting questionable arrow-heads. Molars and tusks of *Elephus primigenius* are frequently met with, but I have not yet realized my desires in respect to weapons, even with the assistance of my boys, whose eyes are sharper than my own. I hope, however, to do so.

In the Charles Museum we have a flint celt of orthodox type, like that drawn in the "GEOLOGIST," fig. 37, p. 19. This specimen was found at the top of the chalk escarpment, above Kit's Coty House, and was lying in what is termed a "pot-hole," near the surface, and associated with other flints, as they are usually seen, in great abundance. The "pot-holes" I believe to be caused by the subsidence of the clay and flints into sandpipes of large area. I intend visiting this locality again, and if anything worth notice turns up, I shall communicate it.—Yours very truly W. H. BENSTED, Maidstone.

GEOLOGY OF CADIZ.—SIR,—Would you kindly refer me to any books or memoirs in which may be found some account of the Geology of Cadiz?—Yours, &c., SEBASTIAN BAGGS.

We cannot find any work descriptive of the Geology of Cadiz. This city is situated on the Tertiary beds, which form part of the Guadalquiver basin, as may be seen by reference to either Dumont's or Murchison and Nicol's Geological Map of Europe. It would be advisable for any geologist visiting Cadiz and its neighbourhood to compare the rocks and fossils seen there with the description given of those in Grenada and Murcia by Silvertop ("Geological Sketch of the Tertiary Formation in the provinces of Grenada and Murcia," &c. 1836); and by Ansted (Quart. Journ. Geol. Soc., vol. xv, p. 585, &c.).

ERRATA IN "GEOLOGY OF ATHLONE."—Page 169, 17 lines from bottom, for "any small, &c." read "*my small, &c.*"—Do., 11 lines from bottom, for "Italy" read "*Slaty*"—p. 170, 7 lines from top, for "parallel, crosswise" read "*parallel or cross ways to*"—p. 171, under woodcut, for "strike north and east" read "*north and south*"—the same page read "*Neligan's folly.*" In the list of fossils read "*Naticopsis Phillipsii,*" and "*Loxonema.*"—G. R. V.

Errata in Hutton's Review of Mr. Darwin's Theory.—Page 132, line seven from bottom, for "rare" read "*same,*"—p. 134, line 31, for "watched" read "*matched*"—p. 135, line 12 for "have" read "*has*"—also, line 14, for "larger" read "*longer*"—p. 136, line 29, for "but in the Pampean mud" read "*but the Pampean mud.*"—F. W. H.

Geology of Clevedon—Sir,—Will you kindly answer the following question through the medium of your valuable "Notes and Queries." 1. What strata are developed at Clevedon, near Bristol. Especially can you inform me whether magnesian-limestone is one of them. 2. Whilst at Ashley, Altrincham, Cheshire, in 1860, I found the fossil of which I enclose drawings—What is it? It was discovered in a ploughed field on what appeared to me to be drift. 3. Are those echini found in gravel flint-casts of the interior?—J. C. C., Dedham.

1. Clevedon Hill consists of Mountain-limestone, and some sandstone belonging to the Coal-measures. See Mr. Trimmer's paper on the gravel lying on Cleveland down, in the Journ. Geol. Soc., vol. ix., p. 282, &c., where a section of the hill is given with much interesting information about the Drift-gravel of its vicinity. 2. We cannot say what the specimen is from the figure sent to us. 3. Yes.

Two Species of Chiton from the Upper Silurian Beds of Dudley.—About two or three years since Prof. de Koninck figured and described these fossils from the original specimens in the magnificent collection of Mr. John Gray, of Hagley.

Before describing these species, he reviews the labours of palæontologists with respect to the genus to which they belong.

The genus Chiton was established by Linnæus in 1758, for a small number of living species, and it remained for a long time unrepresented by any fossil forms.

It was not until 1802 that the first species of fossil Chiton was discovered by Defrance, and described by Lamarck in the "Annales du Museum" (t. 11, p. 309), under the name of *Chiton Grignoniensis* This specific name, derived from a locality long famous for the abundance of its fossils, sufficiently proves that species belong to the Calcaire grossier of Paris, that is to the middle beds of the tertiary formation.

In 1834, Mr. Conrad noticed a species, *C. antiquus*, from the tertiary rocks of Alabama.

About 1836 M. Puzos and the Count Duchastel discovered some remains of Chiton in the Carboniferous limestone of the environs of Tournay. These remains enabled Count Munster to establish a new species which he described and figured in 1839, in the Beitrage-sur-Petrefaktenkunde (I. p. 58), under the name of *Chiton priscus.*

Towards the end of 1840 M. Guido Sandberger announced the probable existence of the genus Chiton in the Devonian limestone of Willmar. In 1842 the same geologist described from it two new species, under the name of *C. subgranosus* and *C. fasciatus*, in the list of Devonian fossils from that district.*

One of these is probably identical with that which Mr. Fred. Roemer has confounded with *Bellerophon expansus*, of Sowerby, and which M. Sandberger designated in 1845 as *C. cardiformis.*

M. de Koninck described, in 1845, three new species of this genus from the Carboniferous limestone of Belgium, to which, in 1845, Baron Ryckholt added

* These specific names were re-placed in 1855 by those of *C. corrugatus* and *C. [illegible]*, without M. Sandberger making known the motive.

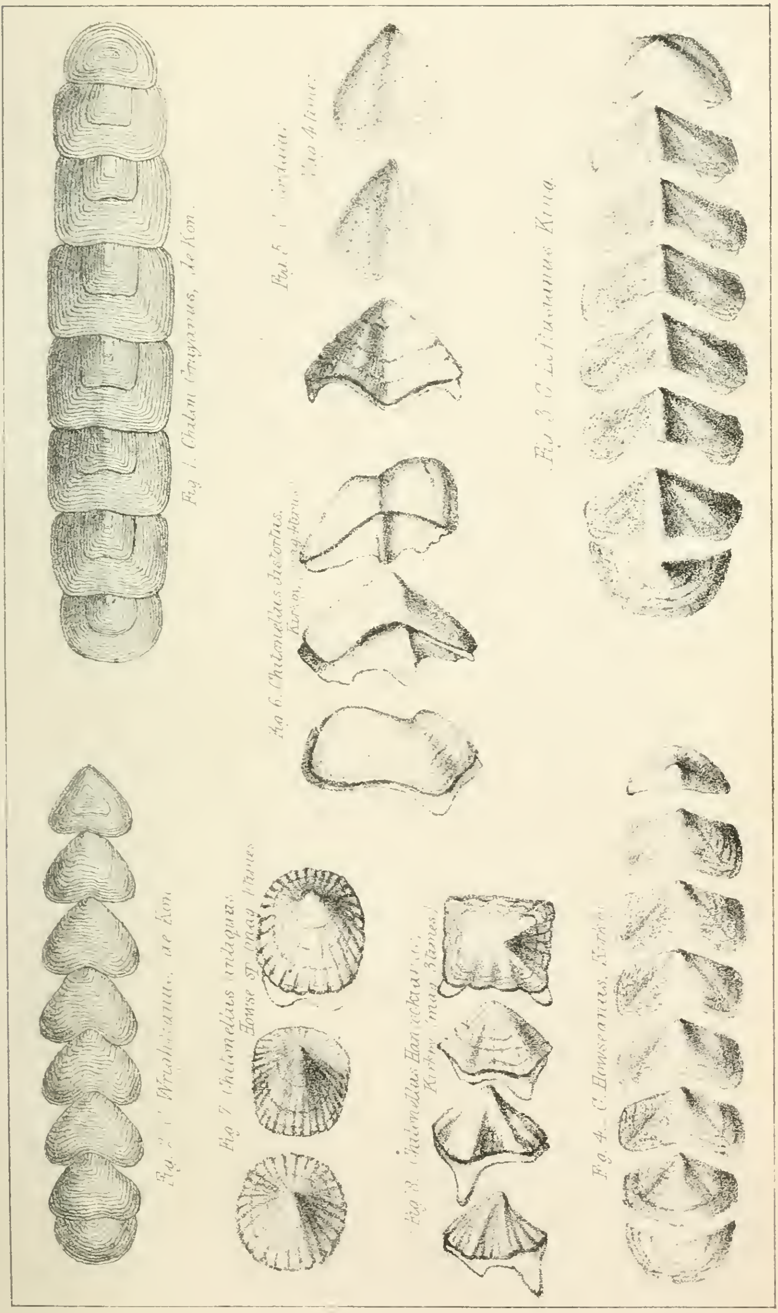


Fig 1. Chiton Grayanus, de Kon.
Fig 3. C. Loftusianus King.
Fig. 4. C. Howseanus, Kirkby
Fig 6. Chitonellus distortus.
Fig 8. Chitonellus Hancockianus

some others discovered by him in the same formation. This savant made known at the same time the existence of a Chiton in the tertiary rocks of Italy. This species, the knowledge of which is due to the researches of M. Cantraine, professor at the University of Ghent, will be described by him under the name of *C. subappeninus*, in the second part of his "Malacologie Méditterranèene et Littoralis," unless it should be identical with that of the environs of Turin, published in 1847 by M. Michelotti, under the name of *C. miocenicus*.

Before the publication of Baron Ryckholt's work, Mr. King had already announced the presence of a Chiton found by M. Loftus in the Permian beds of the environs of Sunderland, and described afterwards under the name of *C. Loftusianus*. On the other hand, M. Philippi had made known two other species *C. siculus* (Gray), and *C. fasicularis* (Linnæus), from the tertiary formation of Sicily.

To all these discoveries Mr. Salter, in 1846, added another, not the least remarkable, that of a species of Chiton, in the inferior Silurian strata of Ireland. This author proposed on this occasion a new genus under the name of *Helminthochiton*, destined to receive solely the palæozoic species; but as the proposed genus is not distinguished in any essential characteristics from the ordinary genus *Chiton*, Prof. de Koninck considers it useless; and at most it could only serve to designate a section from the last.

In 1848, Mr. Searles Wood described and figured in his magnificent "Monograph of the Mollusca of the English Crag," three species of fossil Chitons, of of which one was new *C. strigillatus;* and the other two identical to species now living in our seas, *C. fascicularis* (Linn.), and *C. Rissoi* (Payr).

About the same time M. Eudes Deslongchamps, to whom science is indebted for a great number of excellent works upon the Jurassic fossils of the environs of Caen, discovered in Bathonienne beds at Langrune the posterior or anal plate of a species of Chiton, which he dedicated to M. de Koninck. This was the first discovery of the genus in the secondary rocks.

In 1852 M. Terguem added another link to the chain, which bound the palæzoic Chitons to those of our own epoch, by the discovery of another new species, *C. Deshayesii*, in the middle lias of Thionville.

Lastly, M. F. A. Roemer, described and figured in 1855, a new species of Chiton, *C. lævigatus*, from the upper division of the Devonian formation of the environs of Grund; and figured another, without naming it, and for which De Koninck has proposed that of *C. tumidus*.

The following is a list of all the fossil Chitons known to this day, with the geological formations and localities where they have been found.

UPPER TERTIARY.

1. *Chiton siculus*, Gray. Sicily.
2. ——— *fascicularis*, Linn. Sicily, Sutton.
3. ——— *Rissoi*, Payrandeau. Sutton.
4. ——— *strigillatus*, Wood. Sutton.
5. ——— { *miocenicus*, Michellottti. Turin. / *sub-appenninus*. Cantr?
6. ——— *subcajetanus*, Poli (ex fide d'Orb.). Turin.
7. ——— *transenna*, Lea. Virginia.

LOWER TERTIARY.

8. ——— *antiquus*, Conrad. Alabama.
9. ——— *Grignoniensis*, Lamk. Grignon.

GREAT OOLITE OR BATHONIAN.

10. *Chiton Koninckii*, Eudes Deslongch. Langrune.

LIAS.

11. *Chiton Deshaysii*, Terquem. Thionville, Permian. (See appendix on the additional Permian species determined in 1858, by A. Kirkby.)

12. *Chiton Loftusianus*, King. Humbleton Hill.

CARBONIFEROUS.

13. *Chiton concentricus*, De Kon. Visé.

14. ——— { *gemmatus*, De Kon. Visé.
——— ———, var. *Mosensis*, De Ryckh. Visé.
——— ———, — *Viseticola*, ——— —
——— ———, — *Legiacus*, ——— —
——— ———, — *Eburonicus*, ——— — }

15. ——— *priscus*, Münster. Tournay.
16. ——— *Nerricanus*, De Ryckh. Tourney.
17. ——— *Turnacianus*, ——— ———
18. ——— *mempiscus*, ——— ———
19. ——— *(Chitonnellus) cordifer*, De Kon. Tournay.

UPPER DEVONIAN.

20. *Chiton laevigatus*, Fr. Ad. Roemer. Grund.
21. ——— *tumidus*, De Kon. Grund.

MIDDLE DEVONIAN.

22. ——— { *corrugatus*, G. F. Sandberger. Willmer.
——— *cordiformis*, G. Sandberger.
——— *priscus*, G. Sandb. non Munster.
——— *Sandbergianus*, De Ryckh. }

23. ——— *sagittalis*, G. and F. Sandberger. Willmar.
24. ——— *N. sp.* Plymouth (Geol. Surv. of England).

From an inspection of this list, notwithstanding their relatively small number when compared with living species, the Chitons have their representatives nearly throughout the series of sedimentary rocks; and that up to the present it is only in the cretaceous and jurassic formations that no traces have been discovered. Without doubt, this gap will be soon filled up; for it is not probable that animals, of which the first appearance dates back, so to speak, to the epoch in which life commenced, should have had their race extinct for two geological periods, the duration of which was not less than that of most of the others which preceded or followed them.

This list demonstrates, moreover, that next to the tertiary formation the carboniferous deposits seem to contain the greatest number of species; and that the intermediate beds furnish the least. Two new species next form the subject of a notice from Professor De Koninck: one he dedicates to Mr. John Gray, its discoverer; and the other to Dr. Wright, of Cheltenham.

In March, 1859, Mr. J. W. Kirkby, of Bishopwearmouth, described some new species of Permian Chitonidæ, in a paper read before the Geological Society of London,* namely, *Chiton cordatus*, *Chitonellus Hancockianus*, and *Chitonellus distortus*. He also revised the descriptions previously given of *Chiton Loftusianus*, King, and *Chiton Howseanus*, Kirkby; also of *Chitonellus antiquus*, Howse. sp.

The specimens which supplied Mr. Kirkby with materials for these determinations were all from the magnesian limestone of the neighbourhood of Sunderland, in Durham, and chiefly from Tunstall Hill.

Mr. Kirkby alludes in his paper (Op. Cit., p. 611) to the great similarity that some of the plates of these fossil Chitons have at first sight to *Patellæ* and *Calyptrææ*, and recommends that special care should, therefore, always be taken in the determination of patelliform fossils.

* See Quart. Journn. Geol. Soc., vol. xv., p. 607, and plate 16.

THE GEOLOGIST.

JUNE, 1861.

PROJECTED EXPLORATION OF ICELAND BY THE ALPINE CLUB.

We are glad to find this interesting and little-known country is likely to be visited by some of the members of this enterprising club. The address recently delivered by the Vice-President, Mr. William Longman, now lies before us, illustrated by a neatly-executed map of the wild volcanic island he seeks to bring, in a special manner, before scientific notice. It is quite surprising to think that a country so rich in the physical phenomena of moving glaciers and active volcanos has "never been explored or even visited" by any traveller who has made a study of such great causes of surface-aspect. Certain work has, however, been done, and what records of it we have been able to meet with are appended to this article. Most of them are books available for study, and for this special work perusal of them will be useful, as no doubt a goodly company of physical geologists will answer Mr. Longman's call; for existing glacial conditions in Iceland are more likely to aid them in learning the operations of the post-pliocene glacial eras, which in Britain have left such abundant records of their existence.

No one who has read the last "Edinburgh Paper," by Mr. Robert Chambers, "Ice and Water," can fail to see how greatly our comprehension of the recent arctic condition of the British Isles will be aided by examination of that icy fringe of the northern zone, which has of late so materially influenced our climate, as if we were again menaced with a southerly extension of polar ice.

The geological value of the study of Icelandic glaciers is well set forth by Mr. Longman, when pointing out the heaps of sand and clay bedded in their substances, which, when the progressive motion of the glacier from the jökull or ice-mountain is stayed, are seen to form "catenation of small hills round its base"—features in the natural arrangement of surface-material to be paralleled in the mountain-districts of Wales and Cumberland.

And although these histories of arctic and sub-arctic conditions come in at the close of the geological record, yet they are by no means insignificant in their operations, nor were they slight in their duration.

The Pleistocene age of Scotland is shown by the researches of Mr. Chambers to contain within its limits seven periods, marked by distinct deposits, each the result of an important physical alteration of surface-aspect. The descending order of these, ending with the deposition of the boulder-clay which inaugurated arctic conditions, is thus stated by him:—

1. Vegetable soil—mosses.
2. Ancient sea-margins—erratic blocks from sub-aërial glaciers.
3. Ancient valley-glaciers and moraines.
4. Beds of sand and gravel.
5. Upper boulder-clay, marking a short but violent sub-aqueous glacial drift.
6. Deposit forming brick-clay, with sandy beds and gravel.
7. Boulder-clay; laid by sub-aqueous glacial conditions, with moraines of ice.

Most of these were continued into England, or have their equivalents there, and are now, from the nature of their contents, attracting the chief attention among geological observers. The ancient flint-weapons and implements fashioned by human hands come from the gravels of the fourth and sixth periods, and, indeed, there is reason to believe, were in use by human inhabitants of high grounds during the seventh or true boulder-clay period, at the time that wide-spread deposit was being laid in the valleys.

But the observation of modern glacial conditions in Iceland is not the only way in which existing phenomena can be used with advantage in the interpretation of by-gone history. The formation of the gypseous and saliferous marls of the Triassic series is very imperfectly understood, and nowhere so well as in Iceland can be seen the operations of mud-springs charged with muriates and sulphates, such as form the well-marked features of the "red marl" deposits of England, and which may have resulted from some such operations of subterranean heat.

The war between Huttonians and Wernerians is not *quite* so fierce now as when Sir George Mackenzie, himself a stout supporter of the great Scotchman, visited the volcanic tuffs and scoriæ of Hecla; but many igneous minerals are yet unsolved, and very good help may be given by a careful study of the "Pearlstones," silico-aluminous deposits, and others so abundant in the volcanic regions of Iceland.

Again, another field of observation was opened seventeen years ago by Prof. Ehrenberg, and has not, to our knowledge, been entered by any one since. Volcanic products erupted from the craters of Iceland have been carried in the shape of "meteoric dust" to a distance of five hundred miles. A good example of this is the case of the ship "Helena" of Copenhagen, covered with a layer of ashes and dust when at a distance of five hundred and thirty-three English miles south-east of Hecla. To this mountain, then in eruption, the cloud of wind-blown volcanic matter was traced, and the result showed that the same silicious-shelled infusoria contained in it were also to be met with in the dust which had settled upon the flanks of Hecla, and by colour, appearance, and contents, the transported dust was identical with that which had settled upon near-lying places.

In connection with this, Prof. Ehrenberg suggests that it would be of the utmost value to secure samples of dry ashes of any kind that have not been wetted since their eruption; and that if any traveller in the volcanic region was fortunate enough to be upon the mountain while ash or dust of any kind was being emitted, it would be important to secure a specimen of such deposit before it had been subjected to atmospheric or aqueous influences, so that the important question may be settled whether organic bodies do exist in matter emitted from volcanic vents.

Other questions, the settlement of which is desirable, will no doubt suggest themselves to those geologists who join the expedition, but the above-mentioned seem to us specially worthy of an onward stage, and we do not expect that to the science-loving members of the Alpine Club they will be suggested in vain.

List of Books relating to Icelandic Geology.

Uno Van Troil. "Letters on Iceland." London: 1780.

J. Wilson. "Notices respecting the Geology of Iceland." ("History of Mountains," vol. 3, p. 5, et. seq. 1810).

Sir George Mackenzie. "Travels." Edinburgh: 1811.

Ohlsen (Lieut). "Mémoire sur les jets d'eau bouillante du Geyser et du Strok Islandt." "Journ. des Mines," tome 31, p. 5, 1812. ("Trans, Ac. Roy. Sci. Copenhagen," 1825).

W. J. Hooker. Notice of his "Travels in Iceland." Taschenbuch van Leonhard. Rwolfter Jahrgang, 1818.

Menge. "Notice of a Mineralogical Journey through South, North, and East Iceland." ("Edin. Phil. Journ.," vol. ii., p. 156. 1820. With map.

Sir G. Mackenzie. "Observations on Menge's Account of his Mineralogical Journey." ("Edin. Phil. Journ," vol. ii., p. 249, 1820).

Dr. Forchhammer. "Account of a Volcanic Eruption in Iceland." ("Ann Phil.," vol. xix., p. 401, 1822. New Series, vol. iii.).

"Notice of the Geology of Iceland." ("Siliman's Journal of Science," vol. xvii., p. 13, 1830).

M. Robert. "Remarques sur la disposition des conches basaltiques de l'Islande. ("Comptes Rendus," Jan. Juier 1839. p. 87).

Bunsen, Prof. "Ueber die Procepe der vulkanischen Gesteins bildungen Islands." (1840., pp. 76).

Bunsen, Prof. "Ueber den innern Zusammenhang der pseudoval Kanischen Erscheinungen Islandes." ("Annalen der Chemie and Pharmacie," vol. lxii., Bd. 1).

Sartorius v. Waltershausen. "Geologischer Atlas von Island." Goettingen: 1853. ("Erlanterungen zum Geologischen Atlas von Island.") Ibid. 1853.

Henderson's Iceland.

Forbes's Iceland.

A LECTURE ON "COAL."

By J. W. Salter, F.G.S.

(Continued from page 183.)

I shall now give a few out of many specimens of coal, to show its composition, and so look at it in a practical point of view. For ordinary purposes, there is no doubt the "best" is the best; but whether that best is Welsh, or Newcastle, or Scottish, I do not pretend to say; for the various kinds of coal are suited for different purposes, and what may be refuse in one direction may be of the greatest use in another.

In experiments undertaken with a view to determine what coals were best suited for our steam-navy, Sir Henry de la Beche and his associates tried nearly all the kinds known in Britain, and compared them too with those artificial fuels which are made up from coal-refuse, and are extremely valuable in their way.

I can only give a few examples, and shall refer my young readers —they are older now than when the lecture began, and will not mind a little dry study—to the book itself, if they require more information.*

They tried these coals to see how much they held of carbon, which supplies the heat; of hydrogen, which gives the flame; of oxygen, which is worse than useless in the coal, though essential in the air that is to support the combustion; and, lastly, the quantity of ashes left after the coal was consumed. Because it is clear that the coal which will give most heat, and make least smoke, and leave the least quantity of ash, provided it be not troublesome to manage, must be the best coal to burn.

Now, our steam-navy coal requires all these good qualities. It must have the strongest heating power for the smallest quantity, and the less smoke it makes the better; for that is not only all wasted carbon, but it betrays the position of the ship, when we would fain keep our enemy in the dark as to our movements. Moreover, it should be a coal that does not break or fly to pieces very easily; for the rolling motion of a ship in a gale is very trying to the materials in her hold. Nor is a coal that burns too quickly, and makes the bars white hot, quite the right thing for men to stand in front of, for a stoker with such a grievance might make sad havoc with the engine. All has to be considered; and I believe the government has rejected Welsh anthracite (so good for furnaces), and taken, in the main, Welsh caking coal. Out of three hundred thousand tons

* Memoirs of the Geological Survey, vol. 2, part 2.

used by them in 1860, nearly one hundred and ninety thousand were Welsh coals.

The various qualities stand as follows; beginning with those which have the greatest heating power. The column standing before the name shows how many pounds of water can be converted into steam by the use of a pound of the coal. The column C stands for the carbon; H for hydrogen, which is greatest in the bituminous coals, and by its blaze adds so much to the cheerfulness of the fire-side. Those coals that have most of it are caking coals, which is an additional attraction. Who does not like to poke the fire? But when stern work is to be done, and every ounce of coal is so much added on to the price of iron—then the coal which has most carbon is in request. O, oxygen, is simply a nuisance; for being combined with (H) hydrogen, it forms so much water—a thing to be got rid of before any heat can be got out of the coal.

The best patent fuels have none of it, and Welsh coal has less than Newcastle, and this than Scotch, as the table will show. My own opinion is, that the further you go north, the more it takes to warm you.

Lbs. of Water.	Best Coals.	C.	H.	O.	Ash.
9¾	Welsh Anthracite	91½	3½	2¼	1½
10½	Welsh, Ebbw Vale	89½	5	1⅓	1½
9, 4-5ths	Irish Anthracite	80	2⅓	—	10
7⅓	Newcastle	81½	6	4⅓	3
7	Scotch Coal	74½	5	15½	4⅓
	Patent Fuels.				
10⅓	Warlich's	90	5½	—	3
9	Bell's	87¾	5	—	5
—	Wylam's	80	5⅓	6½	5
	Inferior Coals.				
8, 4-5ths	Welsh, Rock-vein	75	5	5	11
8½	Forest of Dean	73½	5½	6⅓	10
8½	Borneo Coal (Tertiary)	64½	4¾	20¾	7⅓

We see by this table that a large quantity of oxygen and hydrogen relatively to the carbon is a sign of inferiority; and, of course, a great amount of earthy matter, or ash, is so too. I will add, for comparison, some substances which are not coal yet.

	C.	H.	O.
Peat (from many analyses)	60	6	33
Lignite (fossil wood and peat)	58	6	27
Bogwood	57	6	37
Willow wood	51¾	6	41
Oak	50¼	6	42
Birch	50¼	6	42
Beech	50	6	43

The result is in round numbers: not quite exact.

But then again, no kinds are useless. A coal that has most hydrogen is best for making gas; and the coke will do for the furnace. Parlour-coals should be more caking than those you allow for the kitchen, if such a division could be made. And coal that is so bad that no Englishman would like to burn it, may be exported!

And now we must leave the coal, with one extract from a work that is rather bulky, but full of information. Ronald's and Richardson's "Chemical Technology," vol. 1, treats of fuel and its applications, and from this work what little I have to say of the products of coal will chiefly be taken.* From it we learn that in 1855 the fuel used was divided as follows:—

Household coal	19,000,000 tons
Iron works	13,000,000
Steam, gas, &c.	9,000,000
Export	400,000
	45,000,000
Add for Scotland	7,500,000
„ Ireland	220,000
Total	52,720,000

Our present consumption, as above said (p. 60), is about seventy million tons, and for the future it will probably be greater; and this, remember, is all from the older or true coal-measures. The continent of Europe is supplied, in many places, with coal of a later date.

We must look at some of the products of coal.

It seems hardly necessary to allude to gas, for, like the common blessings of light, and air, and health, we are only sensible what a boon it is when we lose it. It would take a chapter by itself. Gas is now made so carefully, and purified so completely from the deleterious things that once poisoned us, that I believe I am safe in saying that the bisulphuret of carbon is the only impurity they do not remove. Even this, I learn, Mr. Bowditch has lately succeeded in doing.

We are told that a country rector in Yorkshire, Dr. Clayton, of Crofton, first discovered coal-gas; and his letter to the Hon. Robert Boyle attracted attention from the Royal Society—when, do my readers think?—in 1739, fifty or sixty years after! So much for the spirit of discovery at that date. The first person who really used gas for practical purposes, and whose credit ought not to be forgotten, was a Mr. Murdock, an engineer employed by Bolton and Watt in putting up steam-engines at Redruth. He lit up his own house, and afterwards the Soho Works at Birmingham; and even

* I did not know that this celebrated work contained a chapter on the question "What is coal?" till lately, or I should have referred to it at first. The case which gave rise to the discussion was that of "Gillespie *v.* Russell." I need hardly say that my own conviction is, that, in a commercial sense, whatever is a bed of fossil *fuel* is a bed of *coal*. I believe fully that in Dumfriesshire and the county of Down there are beds of fuel made of fossil *Graptolites—sea-animals.* They are very thin beds, but they are true anthracite coal for all that.

made portable gas to light him home from the mines at night. About 1809, the improvement had found its way to London, and one side of Pall Mall was illuminated by gas; and the French, ever on the alert for improvements, lighted parts of Paris with it a few years after. In 1852, four thousand millions of cubic feet were burnt in London alone! and the quantity of coal to supply this was four hundred and eight thousand tons—ten thousand cubic feet or thereabouts to a ton. Boghead Cannel, I learn from Mr. Binney, produces thirteen thousand to fourteen thousand feet per ton.

A table of the products obtained during the distillation of coal is given in the useful work we have referred to (p. 567 in vol. 2); so that may be consulted for details. Besides the coal-tar from the coke, a number of gases are given off, of which the following are to be found in the gasometer:—

Carburetted hydrogen—the principal gas we burn:
Olefiant gas, and some other hydro-carbons:
Carbonic oxide: Hydrogen:
And a very little nitrogen, ammonia, and bisulphuret of carbon—the last a substance they do not as yet remove, though, as above said, they might if they would.

The olefiant gas it is which gives the *bright* light to gas, for carburetted hydrogen without it would produce a very dull flame.

The carbonic acid and sulphuretted hydrogen are separated from the gas by passing it through lime-water. And then there is the combination of stinks (useful in their way no doubt) which make up the "ammoniacal liquor." I can never read the name of this fluid without a shudder. I have fortunately nothing to do with it, and only have time to advert to a few of the products gained by the re-distillation of the coal-tar

An eminent Scotch professor, at the end of one of his instructive courses, was asked by his students what subjects he would recommend them to work at. His reply was characteristic—"Pitch into the residuary phenomena." This is precisely what our chemists have been doing of late years, and that abomination coal-tar has been made to yield us up such precious things, that "we are tempted," say the authors of the book above quoted, "to anticipate the time when within our own borders"—*i. e.*, I suppose, our black borders—"we shall have all the materials for warming, lighting, and cleansing, which our age demands."

Tar and coal-naptha are the products gained by distilling this coal-tar; and when a crude pitch is removed from the tar,an oil remains of great service in lubricating machinery, and the constituents of which, on further distillation, prove to be the same in kind as those in the naptha, although fewer in number. From both, by processes too tedious to go into here, they obtain the celebrated Paraffin (or napthaline, as it should be called), creasote, aniline (from which Mauve and Magenta are made), Benzole, and Toluole, and a number of other -ines and -oles which would not much edify those who are not chemists.

They are either hydro-carbons or carbo-hydrogens, as the case may be. And then there are acid fats, Rosolic, brunolic, carbolic, &c., which are likely to test the skill and research of our chemists for generations to come.

We can glance at one or two only of the more important of these substances.

Paraffine, or napthaline, which, as above said, exists in the coal-naptha, is, however, more profitably obtained by distillation of the celebrated Torbane Hill, or Boghead coal, and some of the Cannel coals, at a dull red heat; though even at this heat only a portion of the oil can be retained, the rest going off in the form of coal-gas. An analysis of an average specimen of the coal is as follows, side by side with an analysis of the pure paraffin itself:—

Boghead Coal.			*Pure Paraffin.*		
Carbon.........	60 to 65	per cent.	Carbon	$84\frac{1}{2}$	per cent.
Hydrogen ...	$7\frac{1}{2}$ to 9	,,	Hydrogen.........	$14\frac{3}{4}$	,,
Earthy matter	20 to 25	,,	Loss or oxygen...	$\frac{3}{4}$	,,
	100	parts		100	parts

And by this distillation, paraffin oil, naptha, and pure paraffin are obtained. The oil, as before said, is used largely for machinery, the naptha for light; so that a railway train may be driven by the coke, lubricated by the oil, and lighted by the naptha obtained from the same cwt. of coal.

From the oil a crystalline substance, which is true paraffin, is obtained by cooling, and when purified by vitriol, soda, and warm water, yields at last the beautiful candles with which most people are now familiar. We can get oil and spermaceti at last without hunting out and destroying the lord of the polar seas.

Such oils and candles are made from other bituminous shales in our own country. Those of Caithness are chiefly bituminous remains of Old Red Sandstone fish! So Miller and Murchison tell us. And his majesty the King of Ava makes most of his pocket-money by sending us the "Rangoon tar" for this purpose.

The only uses that I know of for creasote are curing ham and toothache; for the fluid used for "creasoting" timber is not creasote, but pitch-oil. We have done now with these acrid and tarry elements, and must say a word on the scented ethers which are found in coal.

For, strange to say, in this dark compound of ill savour, lie imprisoned fairy scents which rival the breath of flowers. Their full history may be found in Ure's New Dictionary of Chemistry, or the original papers by Prof. Hoffmann, in the Philosophical Journal. Prof. Hoffmann himself has been a large discoverer in this, as in all other branches of organic chemistry; and I have heard an anecdote of these researches worth recording here. A lady whom he had admitted to his laboratory while these essences were being manufactured, was so charmed with the odour of hyacinth, that she forgot all about the lecture he was giving her, and sent him a basket next day, crammed with flowers from the greenhouse, that he might have more material at command. He is equally great in coal-colours, but of that anon.

Perhaps the most valuable product of coal-naptha is benzole, or benzile (C^{12} H^{16}). The more volatile portion of the naptha has been shown by Mansfeld* to consist chiefly of this substance, a pale yellow sweetish oil, as inflammable as gunpowder. By distilling naptha in a peculiar way, and at a moderate temperature, first *alliole*, then *benzole*, then *toluole*, pass over successively, while the less volatile *camphole* is left in the water. The first named being the most volatile, and the toluole least so, you may get pretty pure benzole by taking what comes midway. By adding strong nitric acid a nitro-benzole is formed, and this was the first-discovered of all these pleasant odours. It is like that of bitter almonds, and is used in fragrant soaps, &c.: and it is not absent from the cook's repertory.

Toluole has the same properties, and from one or other of these substances (for they play a good deal into each others hands, I am told) a varied set of essences—fruits and flowers—jonquil, hyacinth, tuberose, jasmine, are derived. The famed "millefleurs" is a product of gas refuse. How many gallons of it have been washed into the Thames!

To Hoffmann belongs much of the credit of the original discovery of coal-colours obtainable from *Aniline*. It was he who showed that the best of all tests for the presence of this substance was the chloride of lime, with which it produced the Magenta dye. Of course, intelligent chemists had their eyes open: and Mr. W. Perkins, by a series of independent researches, rendered it a commercial product, and France soon gave it a name—Mauve, Magenta, Solferino. Why should bloody victories be commemorated on our peaceful triumphs of science? We do not grudge our neighbours, however, their undoubted scientific fame; and will give them our best coal for the production of "French blue' from carbolic acid. It is now coming greatly into fashion.

By treating Benzole with acetate of iron *aniline* is produced. But it is made in many ways; and has received many names—*Phenylamine*, *Cyanol*, *Benzidam*, &c.

The oil of coal-tar is shaken up with hydrochloric acid, and the clear liquor evaporated till it begins to decompose and emit acrid fumes. It is then filtered: potash or milk of lime is added to separate the acid, and the oils, chiefly aniline (C. ^{12} H^7 N), and leucol (C^{18} H^7 N) remain. This mixture is distilled, and the aniline is found to pass over at about three hundred and sixty degrees, Fahr. It has to be repeatedly distilled to get it pure, and it is best to treat it again with acid, separate this by potash as before, and then again distil.

* Poor Mansfeld, who worked so hard at these ethers, and who discovered *camphole*, literally fell a martyr to his zeal, and died in the odour of sweet flowers; for one of his retorts blew up—and deprived him of life.

The chloride of lime was employed by Hoffmann to test the portions as they passed over; the aniline giving a fine violet colour, while the leucol did not.

The aniline must be crystallized with sulphuric acid to obtain the colour; and the process is thus given in Ure's Dictionary, from Mr. Perkins' account, in brief.

"Dissolve equivalent portions of sulph. aniline and bichrom. of potash in water; mix, and let stand for several hours. Filter, and wash and dry the black precipitate. Digest this in coal-tar naptha to extract a brown resinous substance; and finally digest with alcohol to dissolve out the colouring matter, which is left behind on distilling the spirit, as a coppery friable mass."

To use it, add a strong solution in alcohol to a boiling solution of oxalic acid, and apply when cold to the fabric to be dyed.

But even this is not the last of the coal-miracles. Teetotal advocates may keep watch over every grain of barley; but, alas! we can get alcohol from boghead coal. I never tasted it, nor wish to taste it; but I understand it is yet more sleepy stuff than that from the upper regions. *Requiescat in pace.*

"There is no end," says Mr. Binney, "to the combinations, solid, liquid, and gaseous, which belong to the chemistry of coal. Who shall say these bodies do not change, the one into the other, under various circumstances?" What may we not learn from their investigation regarding the laws—nay, perhaps, even the constitution of matter? And all that is true of coal and its products may be said—leaving a wide margin—for peat and other fossil fuels. They have the same constituent parts, and are among the best of our earthly treasures, although we have sadly wasted them before we knew their value.*

Light, heat, motion, fragrance, and colour—all from coal! What more could the sun himself do for us? Is the heat from below the same with that from above? Robert Stephenson used to say so, and when he saw one of his own locomotives tearing away at the rate of forty miles an hour, would call out, half in fun and half in earnest, "There goes the bottled sunshine."

An acquaintance of mine, who knows coal mines well, gives me the same idea in heroic verse:—

"'Tis the old sun's heat
That now cooks our meat;
'Tis is his bottled up beam
That gets up our steam."

Stephenson was right. It is the light and heat of former days expended in converting carbonic acid and water into coal that is here stored up for man. He can, by again converting coal into carbonic

* Even anthracite was regarded in America, fifty years ago, as incombustible refuse, and thrown away. In 1316, or a little later, it was made a capital offence to burn coal: one man, in Edward 1st's reign, was actually hung for it

acid and water, evolve again that heat and light, and use it in a thousand ways beneficial to his race; nay, essential to his very civilized existence.

> "My heart is awed within me, when I think
> Of the great miracle that still goes on
> In silence round me,—the perpetual work
> Of thy creation—finished, yet renewed
> For ever." BRYANT.

I have said little of iron, though it always accompanies, and is the the very handmaid of coal. For more precious, intrinsically, are these black dirty jewels to England, than her silver mines ever were to Spain. "Give me," said Dr. Percy, in his opening lecture to the working men, "the iron, and the coal, and the brawny arm of an Englishman, and I'll soon have the gold."

In even a short essay like this there have been not a few mistakes due to me, and the printers have to answer for a few more. In p. 10, I said the Whitehaven coal-field—a mere strip—supplied all Lancashire, omitting altogether the Manchester coal-field! I have omitted another point of some importance, viz., the claim which Professor King, of Galway, urges* to have first announced for England, the fact that *Stigmaria* was the root of Sigillaria. I have looked over Prof. King's statements, and am bound to say that he argues the case very ably, and that he certainly thought it was the the root as early as 1842, and gave anatomical reasons for so thinking, as Prof. Brongniart had done in the "Archives de la Museum d'Histoire Naturelle" three years before. Prof. King quotes him for these, so that he does not claim originality on this point.

But the fact will still remain that Mr. Binney, who had been looking out in England for many years to find specimens to establish his opinion, showed to many friends the trees with roots attached, in the Clay Cross cutting, so far back as 1839, the same year that Brongniart predicted it; and also read a paper on the subject at the British Association in 1843. An able prediction is scarcely less fortunate than an actual discovery; and in this case they were simultaneous, or nearly so.

Again, Mr. Binney, to whom, more than to any living Englishman, we are indebted for what we know of our coal-measures, points out to me that I have committed the usual error, in restoring the Sigillaria tree, by making the roots start horizontally from the base of the stem. They do not so. The four great taproots, if they can be so-called, shoot obliquely down for some distance, like the instep of a foot, before they send off the horizontal bifurcating roots. The cast of the

* See his Monograph of the Permian System in England, p. 9, footnote; also the Edinburgh New Philosophical Journal, 1843.

hollow space left beneath these gave rise to the original figure of the dome-shape of *Stigmaria*, and the idea of its being a floating plant, an idea which has figured in a hundred essays on coal. It is an excellent proof how much our logic may go astray with the premises wrong.

Lastly, as a conclusive proof of the marine nature of coal, the presence of very salt sea-water in it, containing iodine and bromine, might have been, and should have been, adduced.

In p. 13, the printers or I have called paper coal "dysoile", instead of *dysodile*.

In p. 183, I am made to say that plants give out less carbonic acid at night than they take in (by day). The words in brackets should not be left out.

But if I attempted to fill up all my own omissions I should fill this number. The greatest fault of all is to have talked in p. 13 of finishing in the next number or so, and then extend over half the year.

A subject of such vital national importance; a traffic which employs directly half a million of our countrymen; and whose yearly value, as raw or manufactured material, represents such enormous capital, cannot be a subject of indifference to any man.

The question whether we can afford to go on digging away at the present rate, or even a greater one, and exporting to other nations as well as keeping up our own steam, has been already answered by my friend, Mr. Hull, in his excellent little book, "The Coal-Fields of Great Britain."* His results are summed up in the last page, and may be briefly given.

"1. There is coal, at various depths, over much larger areas than our maps give, down to depths of nine thousand or ten thousand feet, of which we are never likely to reach more than four thousand feet, from increase of temperature.

"2. There is a supply of coal within the smaller limit enough to afford sixty million tons a year for ten centuries."

When our coal-fields are being exhausted, then the grand untouched deposits of America will come into play. Let us get out all we can; distribute it as widely as the arts of peace require; use it as carefully as such a blessing should be used, and do all the good with it we may.

* 1861; Stamford, Charing Cross. A new edition is in the press.

NOTE ON THE GEOLOGY OF SUNDAYS RIVER, SOUTH AFRICA.

By G. W. Stow, Esq., of Port Elizabeth.

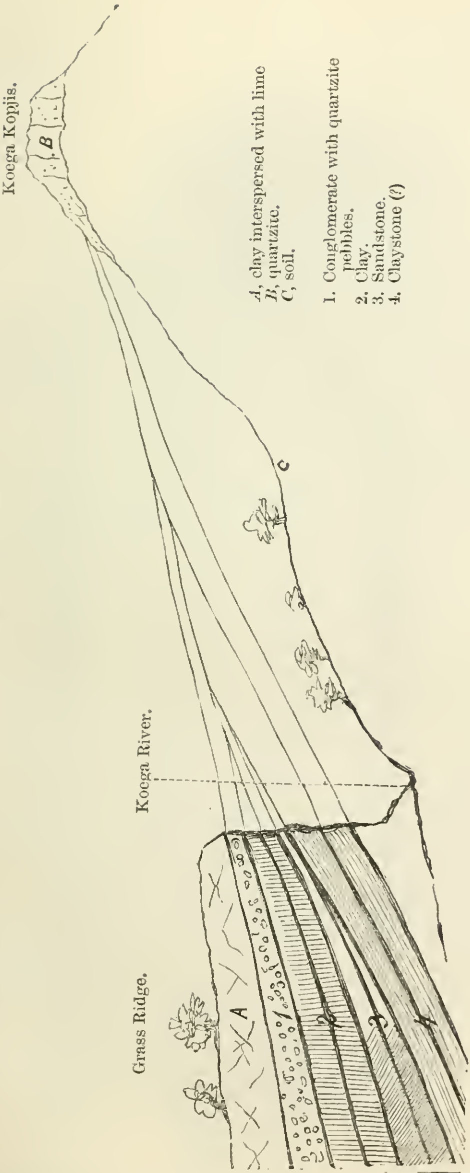
A friend and myself undertook a geological excursion a little before Christmas, along the banks of the Sundays River. We started on horseback, and extended our researches some sixty or seventy miles along its banks, examining every kloof and krantz that appeared at all promising. The incidents that befel one on such a trip but add a lively and pleasurable excitement to such an undertaking: now suddenly coming upon a cobra; anon falling upon the the fresh spoor of a tiger; finding ourselves fast on the side of a krantz, with the river running some hundred feet immediately below us; being hooted at by baboons, for invading their solitary realms; or, lastly, finding the river risen on our return in the evening, and having to make a dash—and swim, splashing through—as best we could on horseback (with nether garments tied around one's neck), to regain our quarters for the night. My friend was very successful, and made a collection of many beautiful fossils. We discovered in some places natural basins, in the hills bordering the river the sides and bottoms of which were literally strewed with scores of magnificent specimens of Trigoniæ and Pinnæ broken out entire from the projecting shell-strata,—in fact, being so numerous that it was difficult to know which to select.

I enclose rough sketches of the Koega Kopjis and of the St. Croix Islands, as they are now seen from this place. They appear so alike in their conformation—the former isolated quartzite hills rising from the plain, the latter islets some little distance from the mainland—that one is urged to the conclusion that their strata must be equally alike; and that as the latter are situated now in the present, so must the former have been islands also, in the far more ancient ocean in byegone ages.

The islands here spoken of I have not visited: but I have been informed by Dr. Rubidge, that they are quartzite also.

That such was the case, with regard to the Koega Kopjis, is proved most conclusively by the following sketch of an exposed section, on the banks of the Koega River, about three hundred yards from the foot of the hills, on the north side towards the Sundays River.

Here it will be noticed that the different strata vary most considerably in thickness; and that from five, six, and more feet in thickness, they gradually decrease, as in some of the more central ones, until they are not more than a few inches. It is also very noticeable that the narrower the different bands of strata become, so in proportion their dip increases,—exactly, as it must have been as



SECTION ON THE BANKS OF THE KOEGA RIVER ON THE NORTH SIDE OF THE KOEGA KOPJIS.

the waters shallowed towards the ancient shore. That the strata marked 4 were more even in thickness, I should imagine, arose from their being deposited in deeper water; the intervening portions must have once extended from their present position to the shoulders of the hills mentioned; but have since been denuded by the same influences that have formed the present bed of the Koega River.

This section I have looked upon as a most beautiful exemplification of an ancient island in the primeval ocean.

Not far above us arose those time-worn quartzite hills that had been exposed to the scorching suns of unknown summers—summers at a period so remote that numberless races have appeared and disappeared from the face of the earth since their tops first emerged from the deep. Never since that time have they sunk so much as to have been again covered by the surrounding waters, but must have remained islands in the distant main when a magnificent and glorious estuary, of which

KOEGA KOPJIE.

As seen from the South.

a. Sunday's River (heights).
b. Grass Ridge.
c. Zwartkops River.

such evident traces are visible, stretched away towards the feet of

St. Croix Islands.

1. Sunday's River (mouth).

the Winterhock and Zuurberg mountains: when the Enon conglomerate was rolling shingle on the beach, when over that subsiding stratum the sediment of ages was forming the sandstones of the Zwartkops and Sundays Rivers, under the dark blue waters in which the ammonites, trigoniæ, pinnæ, and numberless other creatures, whose remains we find, lived and died.

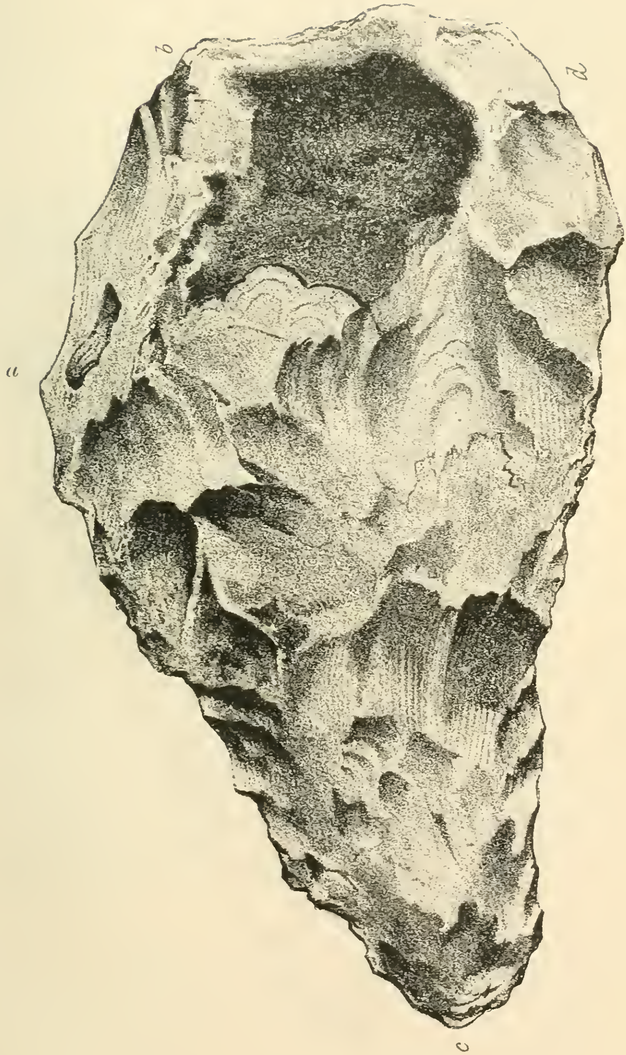
Portions of those sandstone strata must have in their turn emerged, for a time, and become dry land, and their surfaces have been covered with vegetation whose vestiges are now shown in the fossil ferns, &c., found in the neighbourhood of the latter river: and they were again covered by the advancing ocean while the upper conglomerate and clays were accumulating, with all their more recent fossiliferous treasures; and for the whole of this enormous period must those rugged and weather-beaten hills, from their bare appearance and present position, have stood undaunted by sunshine or wintry blast as islands in the ancient main, calm spectators of the mighty changes that took place around. Our expedition was, however, brought to a sudden conclusion; and many of our intended observations were obliged to be left unfinished.

ON A RECENT FINDING OF FLINT-IMPLEMENTS AT BEDFORD.

By James Wyatt, F.G.S.

[Having knowledge of the important discovery of flint-implements in the Drift-gravel near Bedford by Mr. Wyatt, we requested that gentleman to furnish us with the details of the case, which he has kindly done, and which we have much pleasure in subjoining. Having ourselves seen the implements found, which are of the veritable fossil types, we shall append in a note to Mr. Wyatt's letter a figure of one of them, with some remarks of our own upon it.—Ed. Geol.]

Sir,—I send you, as you request, an account of the discovery, by myself, of flint implements beneath thirteen feet six inches of undisturbed deposits, in drift-gravel, lying on Oolite limestone at Bedford. For several years past I have been a close observer of the Drift, fine sections of which in the neighbourhood of Bedford have been frequently displayed during the excavation for road material, and especially during the construction of the Leicester and Hitchin Railway. From the nature of these gravel beds, and from the number of bones and teeth of the extinct mammals which I have seen taken from them, I formed an opinion that they were the same kind of drift which had furnished the flint-implements at Amiens and Hoxne; and this opinion was greatly strengthened by an examination of the pits in the valley of the Somme last year. I have observed amongst the fossil remains from the lower gravel in Bedfordshire bones and teeth of *Elephas primigenius*, *E. antiquus*, *Equus fossilis*, *Bos primigenius*, *Cervus*, *Rhinoceros tichorinus*, and *Hippopotamus*. From the sand veins of the same drift I have taken the following land and fresh-water shells:—*Helix concinna*, *Velletia lacustris*, *Cyclas palustris*, *Limneus pereger*, *L. auricularis*, *Planorbis marginatus*, *Paludina impura*, *Valvata piscinalis*, &c. The curious little fossil sponges *Coscinopora globularis*, both whole and perforated, are frequently found there also, thus showing many points of similarity with the drift in France. After recently finding flint-implements at Reculver, I renewed my investigations in Bedfordshire, but for a long time without success. It may be added here that the pits do not all display the same complete stratification: they are very variable, and in several places the lowest gravel is not excavated on account of the water coming in; and, indeed, for road-material it is of no value, being principally sand. Such is the case at some of the pits at Kempston and Clapham: whilst those which have been worked at the centre of the latter parish, at Bletsoe, Radwell, Biddenham, Harrowden, and Bedford, have been excavated to the full depth of the



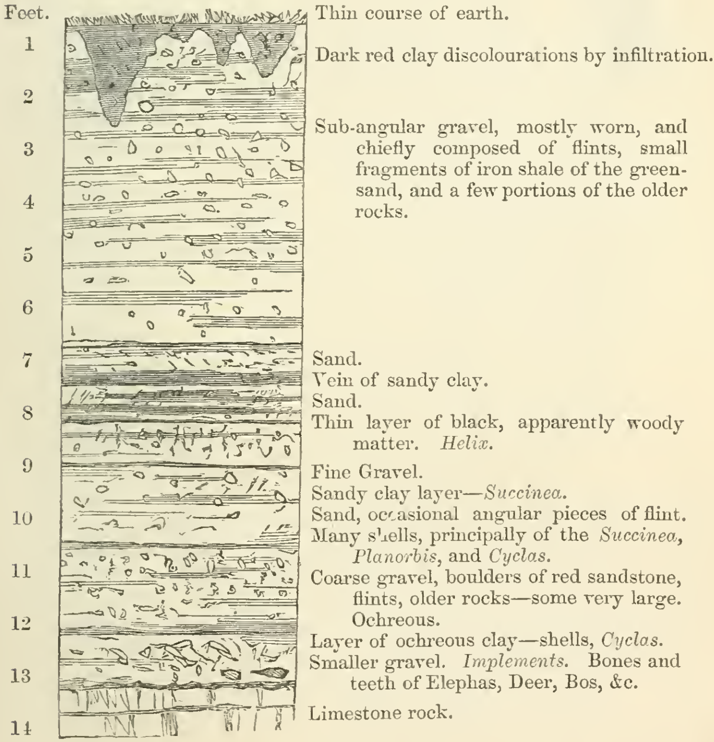
(Front View.)

FLINT IMPLEMENT FROM BEDFORD.

In the Collection of James Wyatt, Esq., F.G.S.

gravel, and in all cases have produced great quantities of fragments of bones, tusks and teeth. These latter pits have been constantly watched by me; and on the eighth of April last on visiting that at Biddenham, I found the men working in the direction where many bones had previously been found, and where a large portion of a tusk of *Elephas primigenius* had been taken out. I went into the pit

Section of Pleistocene Deposits at Biddenham, near Bedford.



and found in the veins of sandy clay which lie between the deposits of gravel several species of fresh-water shells, and in the loose gravel at the bottom I also observed pieces of a large bone. I then commenced a rigid examination of all the gravel which had been taken out of this part, and told the men to look closely at that which they might afterwards throw up. On the heap which had just been removed I found an oval flint-implement, and after further search, I discovered another implement of the pointed kind of the types found at Amiens. I caused the section to be preserved, and immediately communicated the particulars of the discovery to the President of the

Geological Society and other gentlemen interested in the matter; and on the 22nd of April, Sir Charles Lyell, Mr. Prestwich, and Mr. John Evans visited the pit with myself, and made an examination which was most satisfactory. This discovery furnishes many important points of evidence in this inquiry, and as it will probably be referred to not unfrequently hereafter, we append an engraving of the section of the locality. The locality where this discovery was made is in the valley of the Ouse, and is about a mile and a half north-west of Bedford. The gravel lies on the Oolitic limestone, and the pit surface is about fifty feet above the level of the river. The valley at this point is bounded by ridges of Boulder clay, which rise respectively ninety feet on the west and one hundred and thirty on the east. The drift comes in at the northern end of the county, by Sharnbrook, and extends southward through Bletsoe, Milton Ernest, Radwell, Clapham, Bromham, Biddenham, Bedford, Kempston and Elstow; and then goes eastwards through Harrowden, Cardington and Cople. The two flint-implements from Biddenham were exhibited before the Geological Society on the 8th ult., and are very fine specimens. The oval one is worked along the edges throughout, except about one inch of its length, and has a bright ochreous patina all over it of the same tint as the gravel in which it had been bedded. It is nearly six inches in length, and nearly four inches across, at the widest part. One side is smooth and glossy: the other is dull, and has incrustations of carbonate of lime: a certain proof that the implement laid flat in the gravel, and that this side was the upper surface receiving the filtrations from the beds above. The pointed "hache," which is constructed from a grey flint, is seven inches in length, massive at one end and worked off to a wedge-like point at the other, displaying a boldness of design equal to that shown in the finest specimens found at Amiens. It is stained with an ochreous tint, but not so deep in tone as that on the oval implement, and there are dark ferruginous stems along both surfaces. Another of these "haches" has been found near Bedford. Myself and Mr. Nall were returning from the examination of a gravel pit when the latter picked up from some railway-ballast a small one. This ballast had

SECTION ACROSS THE VALLEY OF THE OUSE AT BEDFORD.

A, sub-angular drift-gravel, with mammalian remains, freshwater shells, and flint implements.
a a, boulder clay; b b, Oxford clay; c c, middle oolite.

(Reverse.)

FLINT IMPLEMENT FROM BEDFORD.

In the Collection of James Wyatt, Esq., F.G.S.

been taken out of the gravel pit in the adjoining field, excavated to a lower depth than usual. This specimen is figured in accompanying Plates III. and IV.

It was suggested in Mr. Prestwich's paper read before the Geological Society, that examinations should be made in other parts of the country where the Drift occurs; but our friends who undertake that duty must not be turned from their purpose by some few fruitless searches. I have constantly examined the drift in the vicinity of Bedford for several years before I succeeded in finding any specimen of the flint-implements. It is true that if the pleistocene drift can be determined in any district, there is a probability of these relics being found also; but these must be diligently worked for; and, as Mr. Prestwich has remarked, the motto of the workers should be "Nil desperandum."

NOTE ON THE SMALLER KIND OF LARGE FLINT-IMPLEMENTS, BY THE EDITOR.—THE specimen from Bedford, of which we figure both aspects in Pl. iii. and iv., is an example of the smaller kind of large flint-implements, generally regarded as spear-heads, or as hatchets; but without asserting them not to have been used for one or other of such purposes, we would point out that while the one side, or edge from *c* to *d*, is finely chipped out, the other is not so for its entire length: one portion, *a* to *b*, being either split off flat, as in the present example, or left unworked, presenting the natural surface of the flint, some portion of which will be seen also below the truncated part in our figures. If these instruments be held in the hand this flat part will fit against the palm, generally of the right hand, but some will be held easily only in the left. The suggestion we would make from this is Whether they may not have been used in the hand as flaying-knives to strip off the skins ot the great beasts slain with the larger spears, or with flake-arrows?

We do not wish even to insist on this suggestion; but we are the rather actuated to make it, as very little effort seems as yet to have been made to compare the adaptation of these ancient weapons to the nature and character of the operations they were required to perform. To conpare the fossil implements with those in use by the savage tribes of the present day, or with those found in human graves is right enough, but it is only one sort of comparison. The savage peoples of the present time have no such gigantic beasts as the mammoth and its now fossil congeners to contend with,—the African chase of the elephant, only, being the nearest approach—nor had those of the "grave" period; and it seems only right that we should therefore pass beyond the bounds of mere comparison in our study of their fossil implements, and endeavour to make out and understand the necessary modification of the weapons employed in the pursuit and slaughter of the great beasts, as well as in their own domestic operations, by that primitive race by whom these flint-implements were manufactured and used. The very association of particular *kinds* of animals with the worked flints, and the manner of their association in deposits which are really undisturbed and have not been subjected to torrential action, should be the stepping-stones to the right path of inductive inference, and should be most carefully noted in all discoveries of this class of objects..

HUMAN REMAINS FOUND WITH THE BONES OF EXTINCT ANIMALS IN THE VALE OF BELVOIR.

Dear Sir,—Having occasion to visit the vale of Belvoir, a few days since I met with a few facts which will, I think, be interesting to your readers, and I trust they will induce some of them to make an excursion to that lovely vale the heights of which are crowned with the magnificent castle of the Duke of Rutland.

Fossils in abundance may be obtained from the marlstone, lias, clays and gravels of the drift, &c. In the lias I have every reason to believe there is an abundance of coprolites, judging from what I saw at the residence of William Ingram, Esq., near the castle, an ardent geologist, who possesses an exceedingly good collection from the neighbourhood. In it he has a very interesting young Plesiosaurus. The specimen is not quite perfect, the neck being wanting. It seems evident that the farmers in this district are not aware of the fertilizing agent that exists immediately under the soil.

But the fact which I principally wish you to record is rather important just now, as it bears upon the *vexata quæstio* of the day—the age of the human family. Two hours ride from the castle will bring you to the valley of the Trent, near Newark. In this valley as most of your readers are aware, the Drift is largely developed, and abundance of fossils characteristic of that period may be found, such as mammalian bones of extinct species, &c.; and now I think it is probable the acmé of Mons. Perthes' dreams have been realized, for a part of the human frame has been found commingled with extinct animals. The arrow-head found entangled in the horns of the stag found by Mr. Pengelly at Brixham was vast in importance; it told us by inference that man must have existed along with the extinct animals of, mayhaps, the closing æons of the tertiary era. Some of us strove to look back through the vista of time, but the darkness seemed only intensified by that sudden spark cast athwart the gloom; but the flame of knowledge kindles more and more as the electric light of intelligence penetrates. In the second part of Goëthes Faust there occurs that wonderful scene, where, in the classical Walpurgis night, on the Pharsalian plains, the mocking

Mephistopheles sits down between the solemn antique sphinxes and boldly questions them. and reads their riddles, even so must we boldly question the bones, &c., that constantly turn up, and as boldly read their riddles; and so vague images and gorgeous dreams, that float about like the tremulous sunbeam on the wave, dazzling yet undefined, shall give place to "things of beauty," and so become "a joy for ever." But I have almost lost sight of what I intended to relate. In sinking a pit for gravel, through mould, clay and sand, a human skull was found by Mr. Chowler, of corn-law protection notoriety, twelve feet below the surface, with bones of *Bos*, *Elephas*, *Equus*, &c. The strata evidently never had been disturbed, but were just as originally deposited.

Those who fond of archæology will likewise find in their ramble through the Vale ample gratification: near Bennington is a British encampment, with a circular moat or vallum round, and partly filled with water. I dug out some British pottery, and found some stone foundations formed with Drift from the Oolite, and crammed with fossils: near is also a mound, which I hope to see opened at a future trip. Opposite on the "back bone" of Lincolnshire are extensive remains of another British camp.

There is no doubt but that the valley of the Trent is exceedingly rich in Drift fossils; and I firmly believe the delta of the Soar, near Kegworth, where that river made its embouchoure into the Trent, would well repay a little work. Cannot some of your readers buckle on the harness and set to work?—Yours, &c., FRANCIS DRAKE, Leicester.

[This communication from our correspondent Mr. Drake, reached us barely in time for press. We hope to give minute details of this important discovery of human-remains in our next number.—ED. GEOL.]

CORRESPONDENCE.

THE DARWINIAN THEORY.

SIR,—I read with some regret the article in your number for April, on the "Darwinian Theory:" not that I would be understood to be in any way opposed to the ventilation and free discussion of any subject fairly within the range of scientific research; on the contrary, I believe there is no surer method of testing the numerous theories, which now-a-days so often take the place of facts, than to submit them to the free and open discussion of those who are conversant with the facts which they profess to generalize and explain. Still, when all this allowance has been made, I confess that I *do* feel some little regret at seeing the modernized Lamarckian Theory of Darwin advocated in the pages of your valuable magazine; for I cannot forget that this "development" theory would not only not furnish us with an adequate solution of the facts it professes to generalize, since by the direct admission of its advocates, an admission, by the way, which forms one of their readiest arguments *against* observed facts, its operation is so exceedingly slow and intermittant that it is removed altogether from the range of correct observation, and its verification rendered impossible; but, also, its direct effect would be to shut the Creator out of the world of his own creation, and to set up instead what the Rev. Baden Powell calls "the self-evolving powers of nature."

In arguing this theory Mr. Hutton gives a list of twenty-six "reasons for supposing that variation is at present unlimited," and says that "he knows of no answers to them." He may know of no answers to these arguments; but I don't think it would be very difficult to supply satisfactory answers to most, if not all of them, without having recourse to the "Darwinian" theory, and I have no doubt but that most of your readers have already done so to their own satisfaction. Whether or not, to bring forward a number of isolated statements, many of them sufficiently hypothetical, and make *them* decisive of the question is simply absurd. With greater propriety might those who maintain the constancy of species produce a number of statements of an opposite character, and claim that *they* shall decide the question.

Again, Mr. Hutton professes to have answered the principal objections to the "Darwinian" theory: will he find answers to the following, which I give by way of example? If the Darwinian theory be true, then for long ages before the deposition of the lowest Silurian strata the world must have swarmed with living creatures (Darwin, "On the Origin of Species," page 307). What have become of the "records of these vast primordial periods?" If acquired organs are obtained gradually, how is it then that no specimen in the transition state has ever been found? What will he say to the statement of Professor Owen (Classification of Mammals, appendix xiii, on the "Orang, Chimpanzee, and Gorilla, with reference to the Transmutation of Species"), that "no known cause of change productive of the varieties of mammalian species could operate in altering the size, the shape, or the connections of the premaxillary bones, which so remarkably distinguish the *Troglodytes gorilla* not from man only, but from all other anthropoid apes"? This single statement is weighty enough to decide the whole question, if any statement *could* decide a theory so tenacious of life; and lastly, his theory professes to explain the history of all creation, will he, by way of proving its sufficiency, give us, instead, the history of a *single species* and exhibit, by *facts* its "development from some other? If the "Darwinian" theory *can* do this it will then be time enough to receive it as a true physical law; but if it cannot, then it is a mere dream, and unworthy of the serious attention of the true student of nature.

But leaving this line of argument, which has been gone over again and again only to be again and again disregarded by the transmutationists; and which, after all, is not adequate to decide a question which deals with a compound nature such as that of man. I now turn to another which ought to receive a due consideration in every fair discussion of this theory: I mean the argument derived from the mental and moral powers of man; and in this argument I restrict myself, for the sake of brevity and simplicity of detail, to a single example; but it must be borne in mind that one part of the argument, at least, is equally applicable to every other species of living beings.

The unity of the human species is demonstrated by the constancy of certain osteological and dental characteristics; but he is less characterized by these physical peculiarities than by his mental and moral characteristics. Compare the gigantic grasp of his intellect with the feeble and uncertain mental powers of the most sagacious of the inferior creatures—what analogy is there between them that we should infer the one to be a "development" of the other? Can the "sagacious" brute explore the depths of space, and weigh as in a balance the ponderous orbs of heaven? Can he dig into the bowels of the earth and drag out from thence the buried records of ages, vast as the spaces about him? Can he control the elements, and wield the powers of nature? In all these things, and in a thousand others, the brute is as powerless and insignificant as the man is mighty and all-controlling, and yet in the face of all there are those who, with audacity equalled only by their humility, would link themselves by a bond of identity with the brute, and make their lofty and god-like intellect the transmuted instinct of the brute! To maintain this strange position the first individuals of the race are regarded as savages of the most degraded type in whom the boundary line between the man and brute is scarcely distinguishable, and an upward progress is supposed, produced by the "struggle for life," in which, as generation after generation passed away, the powers of the individual gradually increased until, after the lapse of countless ages, they become what we find them now. This, in brief, is the argument employed to support the "development" theory, but unfortunately for its stability it is mere supposition, and the voice of science, as well as the voice of revelation, gives us a far different account of the nature and powers of original man. The arguments upon this point I need not produce here, they are well known to everyone; but they prove undeniably what the Scriptures of Truth assert, that "man was *made* in the image of God"—that "Adam, the father of mankind, was no squalid savage of doubtful humanity, but a noble specimen of man; and Eve a soft Circassian beauty, but exquisitely lovely beyond the lot of fallen humanity." If, then, the "theory" fails on this point—if it fails to establish a chain of "development" between man and the higher forms of the brute creation—how can it expect to succeed in tracing the connexion lower down in the scale of life! If it cannot trace the sequence of the "development" of the mammal into the man, how can it hope to show the faintest trace of the development of the bird into the man? or, still more hopeless task, of the mollusc or crustacean of the Silurian deposits into the mammal or the man of the recent! And yet this is the theory in favour of which "after taking *everything* into consideration," the balance of evidence greatly preponderates!

But once more, conceding, for the sake of illustration, that the instinct of the brute *might* be "developed" into the reason of the man: nay more, that the incomplex form and vegetative existence of the zoophyte might be "developed" into the highly organized body and magnificent intellect of the man: wondrous concession! Conceding all this, I say what shall we say respecting the *moral* powers of man? Are *they* "developed" too? And if so from what? In many of the inferior animals we may occasionally discover traces of an indistinct reasoning power, in which the willing eye may perhaps see the "undeveloped" intellect of man; but where in the ape, or in *any other earthly thing*, shall we find the faintest traces of that moral nature which so pre-eminently distinguishes man from above every other creature, and which links his earthly nature with the spiritual natures of heaven? In the case of the *intellect* of man, the advocates of the "Darwinian" theory may, with some little show of plausibility, point to feeble glimmerings of reason which have been observed in some of the lower animals, and assert man's intellectual powers to be merely a "development" of theirs. But if they cannot point to the possession of a moral nature beyond the pale of humanity, then I contend that their whole theory fails, and that man, instead of being merely a "development" of some previously existing creature is, in reality, *a new creation*, and if one species is admitted to be an independant creation, and not a "development" the whole theory breaks down; for it becomes impossible, the operation of this supposed law once broken, to fix its limits anew. The whole theory smacks strongly of the unscientific and reprehensible scheme of bestowing upon what they call the "*self-evolving powers* of nature," the prerogative of the Deity, the power to create; so much so that the sooner it becomes a thing of the past the better.

I have this morning got my copy for this month (May), and I find that the conclusion of Mr. Hutton's long and elaborate "notes" is almost entirely taken up by an account of the imperfect condition of the geological records, with the view of throwing upon this imperfection the onus of the fact that *not a single specimen of any species in the transition state* has ever been found. Admitting all he urges respecting the manifold imperfections of palæontology, are these imperfections sufficient to account for the *total* absence of examples of what, if it existed at all, must be considered as the great law of existence? These breaks in the geologic records might be sufficient to account for the *rarity* of these examples: but they do not account for their *entire absence*. How they can be made to furnish an additional argument *in favour of* the "development" theory, I am certainly at a loss to discover. I remember that exactly the same kind of argument was used by Sir C. Lyell ("Principles," 3rd edition), to produce just an opposite result, namely, to prove the theory that *all the great classes of organic life* were created *at once*; and not successively, as inferred from geology. How would Mr. Hutton reconcile these opposite conclusions drawn from the same facts? Or does he expect *his* theory to be better received than Sir Charles'? In conclusion I assert that, while other considerations may be either for or against this theory, geology alone must *decide* it. By the supposed slowness of the operations of the assumed law it is thrown entirely beyond the scope of observation, and unless *actual facts*—facts conclusive and undeniable—can be cited out of the stony records, it must still be considered the mere speculation of a theorist.—Yours, &c., THOS. GRINDLEY, Glossop.

NOTE BY THE EDITOR.—We are sorry that our correspondent should express regret at the appearance of Lieut. Hutton's article on the Darwinian Theory in the "GEOLOGIST." Our readers will doubtless bear in mind what our correspondent has forgotten in this remark, that whenever an article bears the name of its author, *we* are *not responsible* either for its facts or its arguments. Our pages are alike open to Mr. Grindley or Lieut. Hutton—to one correspondent equally with another; and on this point we have always justly prided ourselves on our fair dealing; we have printed the labouring man's communication beside that of the most talented geologist; we have printed even communications against ourselves. Darwin's theory undoubtedly has a most important bearing on geology, and if not wholly accepted, still contains views which must exert a powerful influence on all future investigations.

Granting it to be an error, we would still wish to see it powerfully treated and defended by the ablest hands; for the more powerful the defence of an error, the stronger and mightier the intellect that wields the weapons of its defence, so much the more brilliant will be the victory of TRUTH in the end. We can not have discussions without the defence of error, and without discussions there would be no progress.

In concluding this note, the Editor wishes distinctly to say that he does not consider himself as in any way advocating doctrines contained in any articles excepting in those which are written by himself. On the other hand, he considers the magazine to be, and always to have been, open to the fair expression of any opinion deserving of attention. Moreover, he trusts that friendly discussion and correspondence will be more developed in this magazine than even it has hitherto been.

FOREIGN CORRESPONDENCE.

SPECIMENS of minerals have been sent from Chili by M. Domeyho, for the School of Mines in Paris. 1. Black copper-ore, fibrous. (a silico-aluminate), brought from the mines of Taltat, in the desert of Atacama. 2. Arseniate of copper from the Gerro of las Yeguas, in the district of Rancagua. 3. Arseniate of copper. with sub-oxide from the same locality. 4. Two specimens, arseniate of silver, with antimony from Chanarcillo (one washed in a tube, the other in its original state). 5. Arsenical silver-ore from the mines of Bandurrias. 6. Bi-arseniate of nickel, mixed with arsenical acid, and sub-arseniate of nickel, brought from the mines of San Pedro, situated a few leagues from the port of San Framenco, in the desert of Atacama. 7. Arseniate of nickel, a little hydrated, mixed with a silico aluminate of nickel from the same locality as the preceeding one. 8. Fragment of an aërolite which fell in 1857, in the environs of Hevedia at Costa-Rica.

These specimens were accompanied by a full mineralogical notice of each, and a letter addressed to M. Elie de Beaumont, by M. Domeyko, announcing that he has sent two cases of fossil-bones, found in the same locality he had explored the preceeding year at Taguatagua. He also gave a description of a recent valley containing bones of Pachyderms, situated at the foot of the Andes, and presenting the same features as the great formation two or three hundred leagues on the other side of the range. This circumstance will, perhaps, throw some light on the true epoch of the relationship of this district to the last changes of the Andes M. Domeyko also sends a note on the valley of the ancient lake of Taguatagua on which new light has been thrown by the study of the region above mentioned.

On Density and Hardness considered as distinctive characters of Metalloides and Metals.

M. Marcel de Serres has communicated an important paper to the French Academy on the above subject. "The classes, orders, and families, which have been established in the classification of simple bodies, considered in regard to their hardness and density, appear to be founded on sundry rules, which the comparison of these properties has furnished.

"The metalloides are divided naturally into gases, liquids, and solids, the latter into soft (apalides) and hard (schlerides).

"The soft metalloides, with one exception (phosphorus), are denser than the hard ones: it is principally by the degree of hardness that the two orders may be distinguished."

M. Serres then proceeds to inquire whether the difference between the density and hardness of the metals is as decided as in the case of the metalloides. For this purpose he divides the metals into—1. Heteropsides, which are the lightest bodies among the metallic substances, being in some cases less dense than water. 2. Allopsides, which comprise the hardest bodies in nature, often the schleride metalloides, indicated by the No. 10, in the scale of Mohs. 3. Autopsides, which are again divided into perfect metals and common metals.

From the tables we learn that among the metalloides phosphorus is the least, and tellurium the most dense; and that phosphorus, again, is the softest and diamond the hardest.

Among the metals stilbite is the least, and iridium the most dense; while asbestos is the softest, and emerald the hardest.

On the Extinct Genus Thecodontosaurus.

M. P. Gervais has communicated a notice of the first discovery of the remains of this animal in France. M. Dumortici, of Lyons, who forwarded the specimens to him, found them at Chappon (Ain). M. Gervais refers to the characters of the genus, as stated by Messrs. Riley and Stutchbury in their memoir on the *Th. antiquus* of the

Bristol dolomite (Trans. Geol, Soc. of London, 2nd series, vol. 5, p. 359); and concludes that the animal found at Chappon belongs to the same species, or, at all events, the same genus.

Mineralogy.—Analysis of the "Glossecolite Shepard," by M. F. Pisani.

This substance, which resembles the "Halloysite" in its formation and properties, was found at Dade in the province of Georgia: M. des Cloiseaux, the discoverer, gives the following description of it.

"The glossecolite shepard is compact, and breaks with a conchoidal fracture; it is dull looking, but with rubbing it becomes bright; it is white and sharp to the taste; it does not soften in water, but becomes transparent on the edge and opaline, throwing off bubbles of air, and giving out a strong clayey smell. Soft and very fragile, water is disengaged in the "matras," and the mineral becomes a bluish grey. It is infusible with the blowpipe, and gives a beautiful blue with nitric of cobalt: sulphuric acid attacks it, heat being applied.

"The glossecolite shepard is composed of—

Silica	40·4
Aluminum	37·8
Magnesium	0·5
Water	21·8
	100·5

Some New Geological and Mineralogical Discoveries in the Five Principal Volcanic Departments of France.

M. Bertrand de Lom, in a memoir under this title read before the French Academy gives some interesting details tending to show the great richness of these districts in gems and crystals, especially corundum and crysolite, twelve thousand specimens of the former having been found by him previously to his last exploration, which we may remark, has occupied him six years.

Geological Results of a Voyage of Discovery along the Coasts of the Red Sea.

M. Courbon, surgeon on board a French frigate which has been surveying the coasts of the Red Sea by order of the Emperor, has sent in a very valuable report of the natural history part of the expedition, the geological portion of which, illustrated by numerous sections and five large maps made from notes taken on the spot, will form a very valuable addition to our knowledge of the strata of the districts bordering thereon.

The localities which appear to have been more particularly studied are the bay of Adulis and island of Dissée, Edd and Haycok, Perim and Doomairah. The island of Dissée, formed of a great number of gentle prominences, composed of nearly vertical beds of gneiss, mica-schists and other like rocks, sometimes impregnated with granite, is highly interesting; and M. Courbon's description of it and the neighbouring shore will well repay perusal.

M. Courbon thus describes Perim :—

" Perim is the result of a volcanic eruption below water. The lavas and other erupted matter have first of all raised the coral bed, which formed the bottom of the sea, leaving in its substance some of their remains, and have then forced a passage to appear above the sea-level. This volcano, of which the vast crater corresponded to the whole bay of Perim, has been some time in activity; and has covered the island with mud, cinders, scoriæ. puzzuoloni and, lastly, with the trachytic rocks, which now cover its surface.

" The volcanic action then ceased, and the calcareous sandstones formed: at length a gentle upheaval elevated them, in their turn, above the water; and the island has since that time presented the same appearance that it now does."

The facts collected by M. Courbon, taken in conjunction with those of his predecessors, prove that the Red Sea, which forms one of the most marked localities on the surface of the globe, and of which the eastern side in particular is aligned with a wonderful precision on the great primitive circle of Thuringerwald, which passes Aden, bears traces throughout all its length of eruptive phenomena of immense extent, and of an age certainly not very remote from the present epoch.

On the Age of Fossil Bones, as determined by their composition.

M. Delesse has furnished a paper on this subject, from which we extract the following remarks :—

" When animals are buried their fleshy parts soon decay, whilst the hard part, which forms the skeleton, resists decomposition. Nevertheless, the latter undergoes some alterations that are easily discoverable in comparing the same parts of the skeleton of fossil, with living animals. If one considers particularly the bones, their alterations are shown by the changes in their density and their chemical composition. First of all, it is very easy to prove that in fossil bones their density always augments with age. This augmentation is very sensible, not only in the bones belonging to different geologic epochs, but also those of the present time. In the bones of a man, more particularly, it rises sometimes thirty-four per cent. It is generally higher in the tusks of elephants and mastodons than in their bones. This arises from the destruction of the organic matter or bony substance, and also from the introduction of new mineral substances.

" When fossil bones are impregnated with oxyde of iron, or pyrites, their density rises very rapidly, and is only limited by the density of those minerals. It is difficult to compare the carbonate of lime in a normal and fossil bone; for it varies not only in each bone, but also in each animal

In consequence of the destruction of the bony substance, the carbonate of lime ought to augment in a fossil bone, but this does not always take place. In certain fossil human skulls it falls more than three per cent. although it is at least double in a normal skull: the quantity of carbonate of lime diminishes, therefore, occasionally, in fossil bones, more particularly in the first period of their decomposition, that is, when the bony substance is being destroyed.

But most frequently the carbonate of lime augments in the fossils prior to our epoch. One can easily prove this in those which are cellular, because their cavities are filled with it in a crystallized form. It also increases in the most compact bones, even the teeth and tusks. As the carbonate of lime is found in most rocks and waters of infiltration, it is easy to understand why its quantity increases in fossil bones. The phosphate of lime sometimes diminishes considerably, as low as twenty-five in one hundred, as M. Fremy has proved; sometimes, on the contrary, it rises as high as eighty in one hundred, although on the average it is little over sixty in the normal state. The bony substance is present in fossils, and the azote they contain enables us to arrive at the proportion. Nevertheless, but little remains in the bones found in formations older than the tertiary. The bones which belong to the recent formations, or to the diluvium, contain, on the contrary, a good proportion.

The quantity of azote in a fossil bone depends on complex causes. Firstly, it varies with the bone and the animal. Nevertheless, when one compares the bones of mammals, birds, and reptiles, the difference in the proportion of bony substance does not exceed many hundredth parts, consequently the difference of proportion of azote is reduced to some thousandth parts.

When the bones are fossilized, the azote depends on their exposure to the atmosphere before they were covered up; for the atmosphere destroys organic matter pretty rapidly. It depends also upon the dampness or dryness of the beds in which they lie, and upon the salt or fresh-water which they imbibe. The mineralogical composition of the rock in which they are found must again be considered, because it tends to vary the substances contained in the water of infiltration.

Lastly, the azote in a fossil bone varies with the age. To be convinced of this fact it will be enough to test it in bones belonging to different epochs, and especially in human bones. Although a normal bone contains about fifty-four thousandths of azote, there are but 32·3 in a human bone more than a century old; 22·9 in one of the time of Julius Cæsar; 18·5 in a human skull found by Sir C. Lyell in the Denise beds; 16·5 in a human jaw-bone, which has been forwarded to me by M. de Vibraye, as coming from the grotto of Arcy, and 13·6 in a human cubitus discovered by M. Lartet, at Aurignac.

The human remains last mentioned have been the subjects of much geological discussion; they are regarded as very ancient, and, as we have seen, contain but little azote. Nevertheless, in other human bones which have undergone changes, either by exposure to air or by fossilization, the proportion of azote is still less. A human skull, of which the exact age is unknown to me, and which was found in a marine conglomerate of Brazil, has but 1·6 thousandth of azote.

When bones have been buried under the same condition the quantity of azote becomes better comparable; and then it varies, especially in relation to their age.

According to the observations of M. Lartet, the human bone of Aurignac, above mentioned, was associated with extinct species of animals, especially of the reindeer and rhinoceros. It therefore became of interest to discover the quantity of azote in the bones of those animals.

I have obtained 14·8 for the reindeer, and 14·5 for the rhinoceros of Aurignac. That is to say, nearly the same proportion as for the human cubitus found in the same deposit. Hence, analysis seems to indicate that these extinct animals were contemporaneous with man.

In the grotto of Arcy, M. de Vibraye says there are three deposits of bones, which are very distinct. The upper and most recent one contains unmistakeable traces of the habitation of man, and of animals still represented in the vicinity. In a human bone which came thence, I found still twenty-four thousandths of azote. The middle deposit contains bones of extinct species, particularly the reindeer, in which there is 14·3 of azote: these last are enveloped in a red clay, with a great number of celts and of flint implements. The lower deposit contains bones of *Ursus spelæus*, which contain no more than 10·4 of azote.

It is therefore very evident that the azote varies in the bones from these deposits according to their age; and that it successively diminishes as the age itself increases.

The caverns and osseous breccias contain bones of the hyena, stag, ox, horse, and rhinoceros, which have an equal, or nearly equal, proportion of azote to those of certain human bones of great antiquity.

Analysis proves, consequently, that these animals, belonging to extinct species, have lived on our earth at an epoch not fai removed from our own.

To sum up: a fossil bone is subject to very complex alterations. The porosity and density augment; its bony substance is destroyed; and the proportion of calcareous salts is more or less modified, or altogether destroyed. In the first phase of decomposition, a bone retains a great part of its osseine, effervesces slowly in acid, and loses a little of its carbonate of lime. In the last phase the bony substance has almost altogether disappeared: it is sharp to the taste, and effervesces violently in acid. At this period its carbonate of lime tends generally to augment more rapidly than the phosphate. Sometimes it still undergoes other metamorphoses, which completely alter its chemical composition, although its form remains unchanged.

The testing of azote, then, contained in a fossil bone, permits us to control and verify the assertions of archæology and geology. It can even afford us, within certain limits, indications of its age; and furnishes us with another means of determining relative age in the different epochs of our globe.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geologists' Association.—On the 20th ult. (Whit-Monday), about fifty members made an excursion to Oxford. The party left the Paddington Station at eight a.m., and, assembling at Magdalen Bridge, Oxford, proceeded to Shotover Hill, examining *en route* the Oxford Clay, Calcareous Grit, Coralline Oolite, Kimmeridge Clay, Portland Sands, and the so-called Lower Greensand, which forms its summit.

On the return to Oxford the new museum was visited, under the guidance of Professor Phillips, who pointed out the chief objects of interest in it. The shafts of the columns round the interior of the building are composed of specimens of all the most important British rocks and marbles.

The party next retired to the theatre of the museum, where the Professor gave a short but interesting lecture on the beds at Shotover Hill, which he considered, from the presence in some of freshwater-shells, to be rather Wealden than Lower Greensand. Admission was then kindly given by Dr. Acland to the Ratcliffe library, in which there is a fine collection of foreign marbles.

This was not only the largest muster of the Association for a field-day, but the most important and best conducted excursion yet made; and we record with the highest pleasure any symptoms of improvement tending to raise this Society to the position it ought to occupy at the head of the Field Clubs.

Richmond Institution.—During the last month our esteemed friend and correspondent Edward Wood, Esq., F.G.S., of Richmond, Yorkshire, has delivered two highly interesting and instructive lectures on the Formation of the Earth, to audiences on each occasion of not less than one hundred and seventy persons, at his own residence, the whole of whom, after inspecting the treasures of his choice museum, were hospitably entertained in the most sumptuous manner by the lecturer. The local papers speak highly of Mr. Wood's lectures. One of them says.—

"The lecturer purposely abstained from technicalities, and by the use of the ordinary phraseology rendered his thoughts with so much perspicuity as to be intelligible to the most ordinary capacity. This is a rare quality in lecturers, who, as a general rule, care less about instructing their audiences than appearing learned themselves. Mr. Wood's departure from this ostentatious display of unnecessary learning is well worthy of imitation; and his modesty has been contributory to the information of his hearers. The lecturer spoke for upwards of an hour, with the greatest fluency, though entirely without notes, and was warmly applauded throughout."

Happy, indeed, are our Yorkshire friends in being first entertained with excellent mental food, and then hospitably banqueted on the delicacies of the season. Doubtless, geology will be a very popular science, treated in this manner.

Glasgow Geological Society.—On the 4th of May upwards of twenty of the members of this society proceeded by the Caledonian Railway on their second excursion of this season. The localities examined were Braidwood Gill and Nethan valley, in the Upper Ward of Lanarkshire. At Braidwood station the party were joined by Mr. Forest, who had kindly come from Edinburgh to act as guide, Dr. Rankine, of Carluke, having also sent an escort. On entering the "gill," a wooded ravine, the hammers of the excursionists were soon busy on some transported blocks of very fine greenstone and felstone-porphyries.

The banks of the stream which winds through the glen exhibited various sections of strata consisting chiefly of sandstones and impure limestones; and on arriving at a steep bank of shale containing narrow bands of the latter rock, one of the vice-presidents called the attention of the party to the circumstance that these deposits rested upon Old Red Sandstone, which appeared in the bed of the stream, and were evidently the lowest members of the Carboniferous system in the district; at the same time remarking the strong resemblance these thin-bedded strata presented to the "Ballagan beds," immediately succeeding the Old Red Sandstone of the Strathblane and Campsie districts, so well described by Mr. Young in the first number of this Society's Transactions. In one part of the "gill" an extensive fault was observed, crossing the stream at right angles, producing a vertical displacement of the strata to the extent, probably, of one hundred and twenty fathoms, so that there is a sudden transition from the Old Red Sandstone to the Coal measures, with their characteristic organic remains. Further down the stream a thick bed of limestone, containing *Productus giganteus*, indicates the base of the Carboniferous system, and a relative depth of nearly four hundred fathoms below the "ell coal," which occupies a position near the upper stage of the Lanarkshire coal-field. They then took the shortest route to Crossford, where the Nethan Water unites with the Clyde. Here they were joined by Laird Templeton, an enthusiastic local geologist, who led the way up the valley of the Nethan. On either side of the river fine sections presented themselves, and it soon became apparent that the rocks to be examined were chiefly of marine limestones and clay ironstones, with shales and sandstones, some of the deposits being evidently of estuary origin, and in all likelihood equivalents of the strata in the neighbourhood of Lennoxtown, on the north-west margin of the great coal basin. The only igneous products observed were some rolled fragments of a light-coloured felstone porphyry in the bed of the stream, with a similar rock used as road metal, indicating a trap-area at no great distance. In the lower part of the Nethan hills the strata formed precipitous banks, at one point attaining an elevation of about three hundred feet above the bed of the stream—a fault causing a downthrow to the extent of several fathoms. Further up the river an exhausted opencast coal-pit was observed. Doubts were soon removed as to the true position of the strata, for before long the fossils of the Lower Limestone series presented themselves in the form of various Brachiopoda, the Lingula ironstone indicating a higher stratigraphical order than the Productus limestone of the Braidwood gill. Under a projecting mass of strata a fire was kindled from coal supplied by a seam on the spot, and coffee was prepared and served out to the willing recipients, who had been under the necessity of making considerable exertion in threading their way among the numerous blocks of stone strewn on the banks of the stream. At the base of the lofty eminence on which Craignethan castle stands, a bed of shale was pointed out by Mr. Templeton as containing numerous fossils; and here the party left the course of the river in order to visit the famous archetype of Sir Walter Scott's castle of Tillietudlem. A great portion of the edifice has been removed to build the neighbouring farm houses; but two towers still remain, with part of a solid wall of hewn stone perforated with loop-holes. From the commanding position, the prospect was interesting in the extreme. Round the base of the cliff on which the castle stands winds the Nethan, fringed with leafy verdure, and away in the distance beyond an undulating district the eye could embrace the south-eastern limit of the great coal-field of Scotland. The excursionists then retraced their steps, and on returning to Crossford examined Laird Templeton's collection.

NOTES AND QUERIES.

Sandpipes at Grays Thurrock.—A short time since I visited the chalk pits at "Grays Thurrock," and found the chalk of that district to contain a number of very interesting fossils, especially a large variety of sharks' teeth. The occurrence of numerous sandpipes there is very remarkable. These vary in shape, but the majority are more or less conical. I noticed two, and part of a third, which, from their peculiar form, and other circumstances, causes a difficulty in my mind as to the mode of their formation.

The chalk in the pit in which these are seen has been excavated to a depth of seventy feet, and on all sides can be detected either perfect sandpipes, or the remains of some partially cleared away. Those to which I wish now particularly to draw your attention are on the north side of the working; they are almost close to each other, not being above twenty feet apart. I have traced their depths, one to thirty-five feet, another to forty-five feet below the surface of the chalk, on which the bed of dark red clay containing green-coated flints reposes (No. 6 in the sections, &c.). Their diameters are only about twenty-four inches, and the sides of each are almost parallel, the deviation throughout the whole length not exceeding two inches. It is remarkable that a layer of flints, traceable all round the pit, passes through these pipes (see diagram, fig. 1, *b b*). Por-

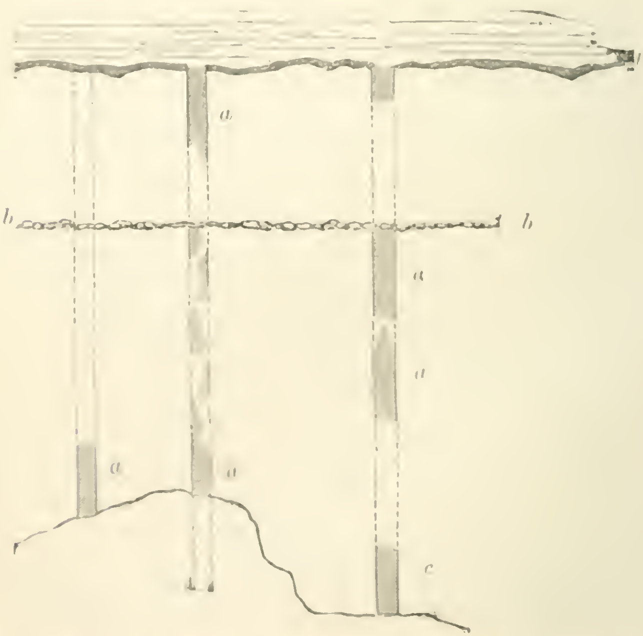


Fig. 1 — *a*, the patches of clay exposed by the fall of chalk; *b*, the layer of flints passing through the pipes; *c*, the point where a flint and its surrounding clay was procured. The dotted lines show the continuation of the pipes.

tions of the pipes have fallen down, giving the patched appearances seen in the illustration. I could not trace the pipes lower than the depths given above, owing to their disappearance in the talus and rubbish at the base of the chalk-platform, which has been left to support the planks on which the workmen wheel the barrows to the lime-kilns. I have preserved a specimen of the sandy clay taken from the lowest attainable depth in one of the pipes (fig. 1, *c*), with a flint that was embedded in it. This mass seems to be a mixture of clay from

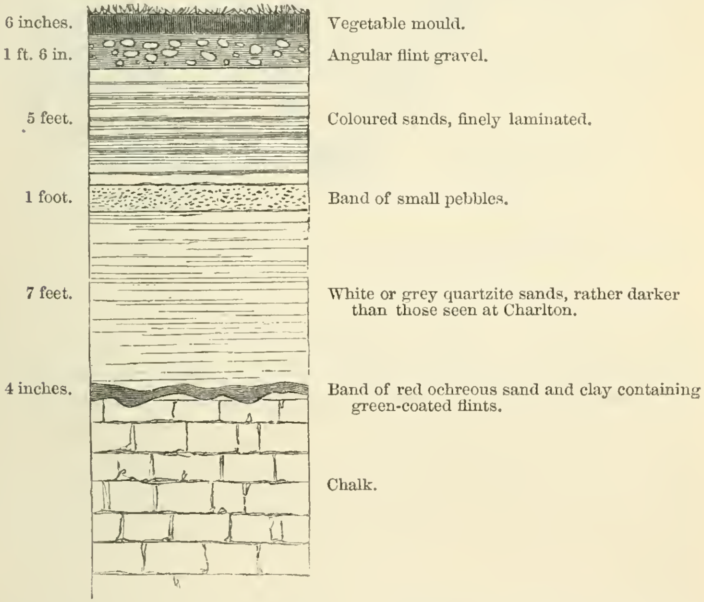


Fig 2.—Section above the sandpipes, showing the strata through which the water percolates.

No. 6, and sand from the superincumbent strata No. 5 (fig. 2); but the white grains of the sand are much discoloured by the oxide of iron contained in the clay No. 6. The flint is not in the least degree water-worn, but has one of its projecting portions broken off, showing the fracture clear and distinct: it is not tinged by the red clay which surrounded it, and still preserves the outer white coating characteristic of chalk-flints. The chalk forming the sides of the pipes is invariably disintegrated for about two inches into the solid mass of chalk forming a cellular or spongy substance, and may by slight pressure be reduced to fine powder.

The extreme depth and uniform width of these pipes, although frequent examples are met with, are not the common characteristics of sandpipes occurring in cretaceous strata, which are generally more or less triangular or funnel-shaped (fig. 3), and this led me for the moment to imagine that they might be fissures into which the clay and sand had been washed or had fallen; but the stratification of the chalk in their neighbourhood being nearly level and quite undisturbed shows this notion not to be tenable; besides, the layer of flints referred to passes completely through the pipes.

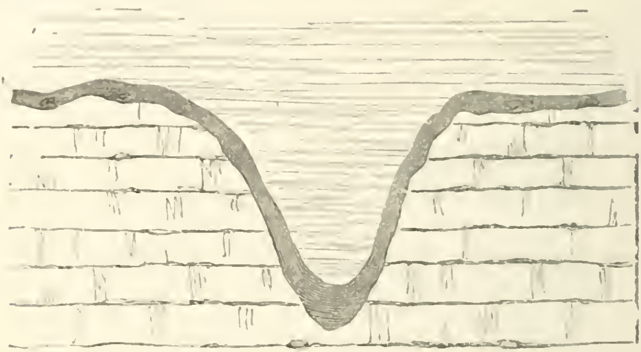


Fig. 3.—General form of the sand- and gravel-pipes at Grays Thurrock, being more or less triangular or funnel-shaped.

There have been two theories advanced to account for the formation of these singular phenomena. 1. The mechanical theory by Mr. Trimmer, which supposes them to be produced by the wearing action of one or more stones, put into rotatory motion by water, at a period when the chalk region in which they occur formed a sea-shore, the waves being the prime moving power, and that the holes thus drilled afterwards filled with gravel or sand. This theory is evidently insufficient to explain these very long pipes, on account of the occurrence of flints throughout the whole depth, and not strewn merely at the bottom, as they would be if the pipes had been worked out by mechanical abrasion; at times flints are found at or near the bottom of sand- and gravel-pipes, but they are not water-worn, and still retain their original shapes, and even their calcareous coatings.

The other theory is the chemical, namely, that the pipes have been gradually dissolved to their present shape by the action of water highly charged with carbonic and other acids, subsequent to the deposition of the sands and gravel above them.

Suppose slight hollows or depressions to be formed on the surface of the chalk, the acidulated water would collect there, and finding the easier passage downwards, there would soon become fixed water channels, and these small

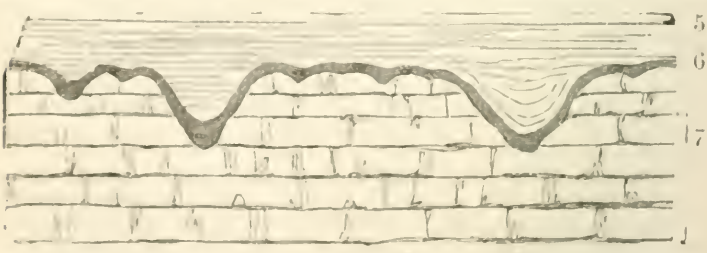


Fig. 4.—Usual appearance of the surface of the chalk, showing slight depressions and incipient sandpipes.

depressions gradually increasing in size by the continuous action of the acidulated water, would grow in proportion to the activity or duration of the errosive action. This action would also be exerted in equal portions round the circumference of the hollow, provided that the sands or gravel above were of a moderately uniform texture, and its result would be to give the pipes a more or less circular, funnel-shaped, or cylindrical form, depending greatly on the solidity of the chalk and the duration of the errosive agent in action. The longer this action continued, the greater would be the tendency to deepen vertically, or in other words, to pass successively from the "cup" to the "funnel-shape" (fig. 3), and lastly to the cylindrical form presented in the diagram (fig. 1).

Mr. Prestwich explains the gradual formation of these pipes in the following manner:—

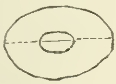


Fig. 5.—Horizontal section of sandpipe.

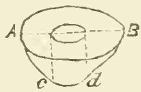


Fig. 6.—Vertical section of one in course of formation.

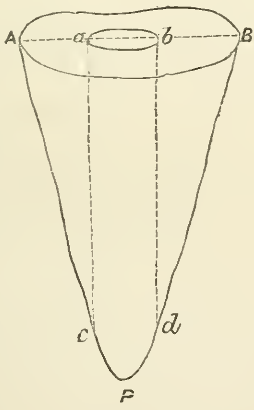


Fig. 7.—Vertical section in a more advanced state, showing where the action ceases, except in a vertical direction towards "*P*."

"If we divide a line drawn through the centre of the horizontal section of the top of a pipe into three equal parts (*A a*, *a b*, *b B*, fig. 5), and carry down two perpendicular lines from *a* and *b* until they meet the sides of the pipe at *c* and *d* in the vertical sections (figs. 2 and 3), it is evident that in (fig. 2) the relative dimensions of *A c*, *c d*, and *d B*, are very nearly the same, the line *c d* being very little less than *c A* or *d B*; still the difference is sufficient supposing equal quantities of water to pass in equal time through the equal widths *A a*, *a b*, *b B*, to make the relative quantity supplied to *c d* greater than that supplied to *A c* and *B d*; consequently in (fig. 3) the water-wear between *c d* would be slightly greater (aided also by the tendency of the water to converge at *p*) than between *A c* and *B d*, and the cavity of the incipient pipe would increase in magnitude more rapidly in the direction of *c d* than of *A c*, *B d*, or in other words, would deepen more rapidly than it widened. Further, as the dimensions of the pipe increased, so would the disproportion between *A a* and *A c*, and between *b B* and *B d*, constantly increase; and as only the same relative quantity of water would pass over the surfaces *A c*, *B d*, whatever their dimensions might be, its effect would be one gradually diminishing, and consequently the lateral growth of the tube would tend to become less from day to day, whilst as the proportion of *c d* with regard to *a b* would continue with little variation, whatever the size of the pipe."

By this explanation we may to a certain extent understand the method in which these singularly long narrow pipes were produced. The pipes that we have been describing in many points seem to accord with the theory of chemical errosion; in their extreme depth, the occurrence of flints indiscriminately throughout, by the uninterrupted passage through them of bands of flint-nodules, and in the disintegration of the chalk surrounding and forming the sides of the pipes.

The patches of clay shown in the diagram (fig. 1) would also prove the disintegrating power of the water on the sides, and that a certain portion of the water escaped in that direction; the inclosed sandy clay, assisted by the oxide of iron, would, as it became dry, attach to itself the powdery chalk, and when, as was the case, masses of the chalk fell down, portions would remain adhering to the clay, while others would fall with the mass of chalk, causing the patched appearance mentioned above. The erosive action was apparently so gradual that the flints were kept in their right position; and so gently has the chalk in the interior of the pipe been removed, that the projecting portions of the flints have not been broken off.—EDMUND JONES.

REMAINS OF AMERICAN "MISSOURIUM" ASSOCIATED WITH FLINT-IMPLEMENTS ("Notes and Queries," p. 217).—As it is very desirable that any matter connected with the assumed contemporary existence of man with the great extinct animals should be cleared up as far as practicable, I wish to append to the paper by Dr. Koch, which your correspondent, Mr. Bensted, obligingly transcribes, an abstract of an article by Dr. Wislizenus (Trans. Acad. Sciences, St. Louis, vol. i., p. 168), in which, after noticing the discovery of the *Mastodon giganteus*, as an upright skeleton in clay, partly consumed by fire, and associated with stone weapons, he takes exception to the conclusion of Dr. Koch, that the animal, while thus mired, was killed by a human onslaught.

After showing that the discovery of Mastodon skeletons in *an upright position* is far from an unusual event, he suggests the following combination of circumstances, as a more natural and likely way of solving the question:

"An Indian family, attracted by the springs, selected centuries ago that place for a residence, and fixed their tent or wigwam on the very spot below which, unknown to them, the bones of the mastodon rested. The ground covering and hiding the bones formed then but a superficial layer, perhaps a foot in depth. The household fire made in the centre of the lodge, as is the Indian custom, and kept up for weeks or months, would be quite sufficient to form the hollow in the ground wherein a layer of ashes would be collected, the heat from which would be quite sufficient to burn, to some extent, the under-lying buried bones.

The presence of stones in the ashes may also be accounted for by remembering that among primitive nations a common mode of cooking is that of burying meat in earth-ovens, dug a foot or more in depth and partially covered by a layer of stones, which would, when heated by the fire at the bottom, assist the cooking-process. Another Indian custom, that of placing stones upon the lower end of thin tents to keep them closer to the ground, may also be cited. If such an ancient lodge was left undisturbed alluvial deposit would accumulate over it in the course of centuries to the depth of eight or nine feet, burying alike mastodon bones and Indian traces."

The discovery of stone arrow-heads mingled with the bones of a mastodon, elsewhere related by Dr. Koch, is of very little value in determining the original question; for these weapons, which are widely distributed over the state of Missouri, have no doubt owed their spread to water-agencies, during the generally accepted human period.—GEORGE E. ROBERTS.

We are much obliged to our friend, Mr. Roberts, for this note. We had been told that the supposed association of man and the "Missourium" had been explained away in this case, but we did not know by whom. We think, however, the original opinion of Dr. Koch, as supported by the traditions of the Indians, at any rate is quite as good a theory, and as much entitled to credence as the other, —the latter seemingly being an attempt to explain away the circumstances noted by Dr. Koch. In all these matters the evidence should be scrupulously examined for the sake of truth, and we must ever be on our guard against the misleadings of prejudice.—ED. GEOL.

GONIOPHOLIS AND SUCHOSAURUS REMAINS IN WEALDEN STRATA.—SIR,—The fossils which I send for your inspection are from the Wealden strata round Cuckfield, Sussex, and I should be much obliged if you would, through the medium of "THE GEOLOGIST," inform me, 1st, whether I am right in the supposition that all the teeth with cylindrical bases belong to the genus Goniopholis?—[Yes]. And 2nd, the one which is compressed to *Suchosaurus?* —[Yes.] (3rd). Does the vertebra, which was found associated with the teeth, belong to either of these two?—[Yes]. (4th). Do not all the osseous plates belong to *Goniopholis?*—[Yes]. And have any dermal bones of the Suchosaurus been found?—[Yes]. (6th). What is the cause of wide irregular grooves on three of the teeth?—[Varietal condition]. If you will kindly answer these queries you will deeply oblige me.—Yours truly, J. C. WARD, Clapham Common, Surrey.

The fossils sent are teeth of *Suchosaurus cultridens* and *Goniopholis crassidens;* bones and scutes of *G. crassidens;* fragment of bone of *Tretosternon Bakewelli (?)* and indeterminable fragments of bones.

These fossils are from the "calciferous sandrock" of the upper portion of the Hastings sand.—ED. GEOL.

ERRATA IN FOREIGN CORRESPONDENCE.—Page 196, line 28, "pressure of the steam = *one seven-eighth*" should read "one and seven-eigths."

ERRATA IN GEOL. OF NEWPORT PAGNALL.—Page 215, line 17 (from the top), for "it takes the place of the Cornbrash of the South of England," read "it *apparently* takes the place, &c.—p. 215, for "Lethbury" read *Lathbury.* In the list of fossils, p. 216, for "Modiola plinaba" read *M. plicata*—for "Cardium globosum" read *C. cognatus*—for "Pecten globosum" read *P. arcuatus*—p. 216, for "Hantwell" read *Hartwell,* and for "Stoke Goddington" read *Stoke Goldington.*—J.H.M.

EXTRACTS FROM MAGAZINES.—DEAR SIR,—Would not a few selected facts and memoranda from the monthly and quarterly scientific magazines relating to geology and mineralogy be acceptable to many of your readers, as there are often discoveries, &c., that occur which are almost unnoticed, at least by many who have not time nor opportunity to glance over the journals that may contain such information, and which is sometimes very valuable? These memoranda, when brought together in such an excellent magazine as the "GEOLOGIST," would prove of much interest to those studying the kindred sciences of mineralogy and geology.

I notice in the Philosophical Magazine for April, an interesting paper on the existence of a new element, discovered by the spectrum analysis, by Mr. W. Crookes, among some seleniferous deposits at a chemical works at Tilkerode, in the Hartz, where, it is well known, many minerals are found in which sélenium and some other elements are combined, such as seleniuret of lead, of silver, of mercury, and of mercury and lead. There are also several other seleniurets in that locality.—Yours, &c., JAMES R. GREGORY.

FRACTURE OF FLINT-PEBBLES.—DEAR SIR,—In reference to the fracture of flint-pebbles from Charlton, p. 73, I would observe that the bed, No. 1, from which they were taken may be considered as having been drifted, from the confused manner in which the pebbles and sand are heaped together; indeed, we may infer, from the resemblance both of the sand and pebbles to No. 2, that they were derived from that bed, probably at some distance off, where it appeared at the surface; and which after being denuded was again deposited and strewn over a large area, part being the locality where our section was taken, and some distance above its true position, which would be No. 2. We may presume (if this took place during the drift-period) that the pebbles were for some time surrounded and suspended by ice, long enough to cause the water they contained, however minute its quantity, to become thoroughly frozen, which, when the mass was thawed, would cause the flints to be traversed by numerous imperceptible fissures. These stones, imbedded in the sands, would hold together, but when extracted, a "tap" with the hammer proves their existence in the shattering of the flint.

In all the specimens broken nearly the whole of the fragments assumed a definite form. The concave and convex sides of each fitting on to the convex and concave sides of its neighbour; and so perfect is this arrangement, that with a little trouble the pebble may be put together by replacing the fragments; and if held firmly in the hand will exhibit scarcely any traces of the numerous cracks.—Yours truly, EDMUND JONES.

CRENATE OF AMMONIA IN AN OLIGIST OF DEVONIAN AGE.—Dr. Phipson has communicated a note to the *Comptes Rendus* for May, on the occurrence of an organic matter in an oligist of Devonian age in Belgium. Its oolitic structure caused him to think that it had been formed by incrustation in marshy tracts of the eggs of aquatic insects, as in the case he described in a former volume of this magazine, of the oolitic limestone in the great lakes of Mexico; and it was this character which, in spite of the antiquity of the rock, lead him now to examine this oligist to find if it had any any organic matter that could be regarded as the debris of plants or of aquatic insects.

The result of this chemical analysis was that the oligist was found to contain more than four per cent. of crenate of ammonia, an azotized organic salt discovered by Berzelius, and the products of the decomposition of vegetable and animal matters floating in water. The mineral contained, moreover, traces of phosphoric acid, whence it is very probable it was formed like the modern ochres, and that it may owe its oolitic structure to the eggs of aquatic insects.

VARIATION OF TEMPERATURE EXHIBITED IN DIFFERENT GEOLOGIC ERAS.—SIR,—Are there any evidences of similar alterations of general terrestrial climate in any of the older geologic periods, such as occurred in the Glacial epoch, namely, periodic alterations of hotter and colder general climatal conditions? Your kind reply would oblige a young student who is much interested in the subject of former climatal changes.—E. WELD, Doncaster.

This matter has just been very nicely treated in Mr. Page's new book "Life on the Earth," where he gives a diagram of undulations in which the Silurian, Carboniferous, Oolitic, Tertiary, and Recent Eras are made to represent the cycles of warmer temperature; and the Cambrian, Old Red, Permian, Chalk, and Boulder drift the alternate colder periods. This idea of colder and warmer cycles as affecting the northern hemisphere was brought some years ago under the notice of the St. Andrews Philosophical Society, and has since been variously discussed, and some good grounds urged for its acceptance.

Opercula from the Paludina-bed at Peckham.—Dear Sir,—The accompanying figures represent some impressions which occur in the Paludina-bed at Peckham, to which deposit reference has before been made in "The Geologist (see vol. ii., pp. 151 and 208). Figure 1 is the most abundant variety, and is of a roundish form, with a sub-central nucleus and concentric markings.

Opercula from the Paludina Bed, Peckham (natural size).

Having, by the kindness of Mr. Pickering, compared this with recent examples, I think there can be little doubt that it is the operculum of *Paludina lenta*, which is present in such vast numbers in this stone. I have lately found one with the horny matter preserved.

Figure 2, of which I have seen but one specimen, and that one not quite perfect, resembles figure 1 in the sub-central nucleus and concentric markings; but differs much from it in shape, being oblong, rounded at one end, and becoming narrower (almost pointed) at the other. I imagine that this operculum must have belonged to a shell with an elongated aperture. Two species of Paludina occur in this bed, but all the specimens I have seen have rounded mouths.

I have not seen a figure of *P. aspera*; but *P. Desnoyersii*, to which the other species is considered to be related, is figured with a rounded mouth by Deshayes.

It being very difficult to obtain Paludinæ with the mouth perfect, either at Peckham or Dulwich, I cannot state for certain that the specimen, fig. 2, is not the operculum of *Paludina aspera*.

The only other univalve that I have met with in the Paludina-band is the *Pitharella Rickmanii*. The operculum No. 2, will correspond with the aperture of that shell; but I find that the Auriculidæ, Achatinidæ, and Lymneidæ, to which families Mr. Edwards considers Pitharella is related, have no opercula.

At a recent meeting of the Geologists' Association, Mr. Pickering expressed doubts as to the correctness of Mr. Edwards' views, and considered Pitharella to be more nearly allied to Ampullaria. This question, however, I must leave to more experienced conchologists than myself.

While on this subject I should like to know whether Mr. Edwards described Pitharella, after a comparison of specimens, both from the Paludina-band at Peckham and Dulwich, and also from the shell-rock at the latter place. The shells that I have seen from the Dulwich shell-rock differ so much (being longer in proportion to their breadth) from those of the Paludina-band which occurs above it, at both Peckham and Dulwich, that I should have thought they belonged to two distinct species of the same genus.

I may add that I think some public notice should be taken of the fact that the first specimen of the Peckham *Pitharella* was discovered by Mr. Edmund Jones, in the strata at Cow-lane, Peckham, and was by him submitted to several geologists (who then considered it to be *Volutu denudata*), some time before the excavations for the main drainage were commenced.—Yours truly, C. Evans.

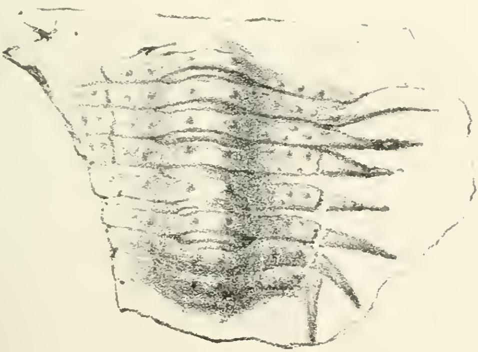
That Mr. Edmund Jones has not had the credit of being the original finder of the *Pitherella Rickmanii* is due to my own casual negligence. The specimen found by Mr. Jones was placed by him in my hands months before the Dulwich drainage-works were begun; and I requested Mr. Jones to show it to Mr. Etheridge and Professor Morris, which, I believe he did; and by whom I also believe the shell was called a Voluta. Not being satisfied with the vague kind of opinion given to him, and the doubts expressed regarding it by those eminent palæontologists, Mr. Jones again left the specimen in my hands, and I placed it aside for careful examination and study; but numerous professional engagements, as well as domestic matters, at that moment engrosing my thoughts, it remained unattended to by me; and was not, singular to say, recalled to my mind, even when making the drawings (which I did myself) of Mr. Rickman's specimens, both for this journal and for the Illustrated News. I am sure this frank acknowledgement of my "sin of omission" will be a sufficient apology to my young friend, Mr. Jones. The indefatigable perseverence of Mr. Rickman in working out not only the fossils, but the stratigraphical details of that portion of the drainage works well deserves the little honour that is attached to the *triviale nomen* of a new shell, of which honour I am sure neither Mr. Jones nor myself would wish to see him deprived, especially as Mr. Rickman's discovery was perfectly distinct from Mr. Jones': the former not having any knowledge, as far as I know, of what the latter had done.

Mr. Jones is an active geologist, willing to do good work, and our regret is that he was not more encouraged to continue his researches by those naturalists to whom he showed the original specimen.

I am not clear that there may not be two species of this new genus, and I have just sent two specimens handed me by Mr. Arthur Bott of Peckham, to Mr. F. E. Edwards, for his inspection and decision. In this case it would be fair Mr. Jones should be honoured with the specific denomination—a slight glorification as rightly due in his case as in Mr. Rickman's—more than usually can be said when personal names are so commonly attached as mere compliments to naturalists who have never seen the objects named after them; or in commemoration of amateur-geologists, who have bought their specimens of working collectors.—S. J. Mackie.

New Species of Trilobites.—Sir,—I saw some weeks ago an advertisement by Mr. Gregory, on the cover of The "Geologist," stating that he had many specimens of *Agnostis rennulosus*, from the Lingula flags; but I should not have noticed the blundering use of a mere MS. name, given by me to a friend for his collection, had I not seen (in p. 212 of your last number) an article by Mr. Gregory, giving three or four other MS. names in the same way—all of which are wrong; and certainly they ought not to have been published, whether right or wrong, for they have not yet appeared in any shape. Lest these mischievous advertisements should be repeated, I must correct the reference so far as to say that the species of Asaphus, and the shells referred to, are from the "Lower Tremadoc slates"—not from the Lingula flags, in which no true Asaphidæ occur.

I shall take this opportunity of advertising in a *scientific* sense, requesting those gentlemen not personally known to me, who may be possessed of good collections of trilobites, to communicate to me their willingness to lend specimens for illustration in the Palæontological Society's Transactions. I hope I may take this means of becoming further acquainted with collections of this beautiful group of fossils. As only a few genera will be illustrated at a time, no unreasonable detention of the specimens will occur.—J. W. Salter, Geological Survey Office, Jermyn Street.



ACIDASPIS BARRANDII.

(From the Silurian Rocks of Dudley,)

FLETCHER & SALTER, (M. S.)

In the Collection of J. Mushen Esq[re]

Sketched from the Specimens

On Stone by S. J. Mackie, F.G.S.

REVIEWS.

Proceedings of the Geologists' Association, No. 6.

Since our last number this part of the Association's proceedings has been issued. It commences with a very good paper by the Rev. Walter Mitchell, on "Crystallography." This is followed by one on a "New Red Sandstone Quarry," at Stourton, in Cheshire, by Mr. Mitchener; and by another on "Brickfields, &c.," by Mr. Pickering. There is another paper on which we can bestow an equal meed of praise, although its main features have previously been presented elsewhere—that by Mr. Rickman on the Dulwich and Peckham beds.

There is one paper, however, to which we cannot help referring in a special but different manner, that on the "Geology of the Isle of Sheppey." We do not know why it should be necessary to print such a paper in full, when neither the geology, the natural history, the English, nor the spelling is at all accurate; while one is so bothered with italics in the printing, that it is difficult to understand and appreciate sentences so full of points.

In the opening sentence we are told of Sheppey that "The island itself is an outlyer, having been split off and *pushed away* to the northward and eastward" (!). We do not know by what rule in orthography outlier is spelt with a *y*; nor do we comprehend how, if it be an outlier, it could be pushed two ways at once. We could understand a mass of rock being pushed to the north-eastward; but even then we should stop to enquire who or what it was that *pushed* it in that direction. As little can we understand the second sentence, namely, that:—"these (the Sheppey) strata were undoubtedly formed below the waters of the Eocene *period* (!) of our theory, though now raised high above the ocean." We know there were Eocene seas, on the shores or bottom of which certain strata were deposited; but "the water of the Eocene period of our theory" is a novel liquid of which we were not previously aware of the existence. We are also in some little confusion of ideas as to what it is that is "raised high above the ocean." The text does not clearly explain to us whether it is the strata, the waters, the Eocene period, or "our theory," which has been thus conspicuously elevated. We do not wish to go into the question of the division of the tertiary beds into crag, Bagshot sand, fresh-water formation, and lower tertiary; nor to argue against the decided preference the author thinks this divisional arrangement possesses over "the rather awkward names of *pliocene*, *miocene*, and *eocene;*" and there are numerous other matters of which we refrain from speaking. Some one said of a book that was *praised* by our cutting contemporary, the Saturday Review, that *it* must be a *good* book indeed when that journal praised it; so, on the other hand, when we, who prefer to leave unnoticed what we cannot conscientiously praise, say there is one passage in this paper which we intend specially to condemn, our readers will, no doubt, think that passage very bad indeed. The author speaks of Septaria—those great argillaceous nodules of the London clay—as being concentrated round an organic body. We do not want to quarrel with this idea; but when we read that "indeed, is it not probable that some mollusc or *jelly-fish* originally formed the nucleus of every septaria; and that the septa were produced after the creature was, perhaps suddenly, enveloped in soft or semi-liquid clay by gases evolved from the decomposing animal matter, causing the *conglomerate* to crack in *virtual* (? *sic*) lines, till other chemical changes taking place the chinks became filled with calcareous spar, often bespangled with crystals of pyrites," we can scarcely refrain from grinning like an ogre, throwing our arms about like a windmill, and with Dominie Sampson in Scott's novel, shouting "Prodigious," till the roof rings with our raptures. The nucleus of that great septarian table-top in yonder corner of the room—so hard, and beautiful, and polished—originating in the animal matter of a *jelly-fish* (!), a ton of which creatures would not leave an ounce of solid material. Has the author of the paper ever seen a jelly-fish? Has he ever seen those shoals of "slutter" melting into water and evaporating on our beaches, without even staining the stones on which they rested? Of all things to form a nucleus—a jelly-fish! the largest of which, weighing three or four pounds, does not leave as many grains of matter; and this too, printed under the sanction of a London committee of a London society, mustering F.G.Ss, and F.C.Ss, and M.M.Ss, and F.R.A.Ss, with one of the council of the Geological Society as president, and an M.A. as honorary secretary. The only excuse we can make for them is, that they must have left this paper on Sheppey to its fate at the printer's, who, certainly, was not a naturalist, much less a geologist.

On the Vestiges of Extinct Glaciers in the neighbourhood of Great Britain and Ireland. By Edward Hull, F.G.S.

In the early part of last year a paper on this subject was read before the Philosophical Society of Manchester, by Mr. Edw. Hull, of the Geological Survey.

"As far back as the year 1821 M. Venetz first announced his opinion, founded on ample testimony, that the glaciers of the Alps formerly extended far beyond their present limits. These views were subsequently confirmed by MM. Charpentier and Agassiz, and are now universally received. But it was not until the year 1842 that Dr. Buckland published his reasons for believing that the mountains of Cærnarvonshire gave birth to glaciers which descended along seven main valleys; and that to these agents are to be attributed the polished, fluted and striated rock-surfaces which may be traced at intervals along the pass of Llanberris and elsewhere. This opinion, at first received with incredulity, was subsequently confirmed by Mr. Darwin and Professor Ramsay.

"The grounds upon which Dr. Buckland rested his conclusions were precisely those upon which M. Venetz inferred formed extension of the Alpine glaciers. The effects of these streams of ice moving along their channels have now been repeatedly observed not only in central Europe, but in the Arctic regions, where they descend into the sea and give origin to icebergs. These effects consist in the polishing and moulding the bottoms and sides of the valleys into smooth oval bosses, or *roches moutonnées*—the production of striæ, flutings and scratches (which are generally parallel in a given locality); also, perched blocks and moraines. The combination of these phenomena in any region can only be attributed to the agency of glacial ice, as there is no other known power capable of producing them. When to these is added the dispersion of erratic blocks, or boulders of large size, over a district extending many miles from the parent masses to which they may be traced, we cannot hesitate to refer the transportation of these blocks to floating icebergs derived from glaciers in a manner similar to that which is in operation along the coast of Greenland, or amongst the fiords of Tierra del Fuego."

The only British district where, as far as I am aware, a detailed survey of the glacial striæ has been accomplished, is that of Snowdon by Professor A. C. Ramsay. The author gives in this paper a short sketch of the glacial vestiges which are to be found amongst the mountains of Killarney in Ireland, of Caernarvon in North Wales, of the Lake district in England, and the Scottish Highlands.

Professor Agassiz, in giving a general sketch of the ancient glacial centres of the British Islands, includes amongst them the mountainous district of Kerry, at the southern extremity of Ireland, at the entrance to which are situated the far-famed Lakes of Killarney. On approaching this region from the east, it is impossible not to be struck with the vast accumulation of detritus, with large boulders derived from the rocks of which the mountains are composed. This deposit of the age of the northern drift is spread over the low-lying district of Carboniferous limestone which extends to the lower lake. On the western and southern sides of this lake the mountains rise abruptly and attain at Carn Tual an elevation of three thousand four hundred and four feet, and here the glacial phenomena are as strongly pronounced as in any part of Wales and Scotland. The Black Valley, one of the most wild and striking, which stretches from the head of the lower lake to the base of Macgillycuddy's Reeks, exhibits these appearances in their most marked form. The surfaces of the rocks are here worn into smooth oval bosses, lying with their major axes in the direction of the valley, and extending several hundred feet up the sides. These polished *roches moutonnées*, however, assume a singular appearance when traced into the upper lake. They rise above the surface in the form of small oval islands, lying parallel to each other, and, though frequently clothed with luxuriant vegetation, are generally smooth and bare. It is impossible to give an idea of these ice-moulded bosses, protruding their naked backs above the calm waters of the lake, bearing some resemblance to a number of up-turned hulls of ships, or to a shoal of whales swimming half out of the water."

Nearly all the main valleys present similar appearances. The rocks, wherever freshly exposed, are grooved and striated: the picturesque valley of Glengariff being specially remarkable for the freshness of the ice-groovings and scratches. These striæ point west-south-west, stretching along the valley till it is submerged in the sea at Bantry Bay.

The years 1841-42 appear to have been remarkably prolific in researches into the glacial phenomena of our islands, for we find Professor Agassiz, Dr. Buckland, and Sir C. Lyell announcing consecutively their convictions of the former existence of a state of things in these islands, which have their analogues only in Greenland, South Georgia, or Tierra del Fuego, at the present day. M. Agassiz pointed to the Caernarvonshire mountains as one of the centres of dispersion of glacial and erratic detritus; and Dr. Buckland speedily followed with details tending to prove that the seven valleys of Snowdonia were once occupied by as many glaciers, discharging loads of boulders and gravel over the lower grounds or into the sea, and covering the bottoms and sides of those valleys with flutings and furrows. He also shows that on the northern flanks of this district, boulders and marine drift coming from Anglesea, Cumberland, or Ireland, and containing, as shown by Mr. Trimmer, marine shells, have been deposited at an elevation of one thousand three hundred and ninety-two feet on Moel Tryfane.

The observations of Dr. Buckland were followed by those of Mr. Darwin, and more recently by those of Professor A. C. Ramsay. This author has shown that many of the tarns, such as Llyn Llydaw and Llyn Idwal, have been produced partly through the damming up of the waters by moraines, as Agassiz had previously shown to be the case in the Alps, and Lyell in Forfarshire. The same author, in order to account for the fact that several of the mountain tarns, as those near the summit of Cader Idris, Moel Wynne and Snowdon, are in the form of basins hollowed out in solid rock, has suggested an explanation which may be called "the scooping theory." These tarns are generally surrounded through half their circumferance by precipitous walls of rock; and Professor Ramsay supposes that solid masses of ice, descending from these heights, charged with imbedded fragments of rock, have actually scooped these hollows, which are so numerous in all mountain districts.

But there is one interesting fact brought out by Professor Ramsay, and which, according to my own observation, is repeated amongst the valleys of the

Lake district. Taking the moraine of Llyn Idwal as one of several examples, he shows that it is situated at about one thousand feet below the elevation attained by the Northern Drift. Now if this moraine had been formed previous to the deposition of this marine deposit (which attains an elevation of two thousand three hundred feet), it would most certainly have been entirely obliterated. It is, therefore, evident that moraines of this kind belong to a period subsequent to the Northern Drift. Bearing this in mind, and recollecting the clear evidence which the *roches moutonnées*, frequently enclosed by marine drift, afford of having been formed by glaciers *before* the deposition of the same formation, we have here a sequence of three distinct, though connected, periods: the first, in which the glaciers descended down the main valleys; the second, when the land of Wales had sunk at least two thousand three-hundred feet, during which the till or drift was spread over the flanks of the mountains; and the third when the land had been elevated, and glaciers again descended from the heights ploughing out the drift, and forming moraines for embankments to lakes and tarns.

The striations of the rock-surfaces of Anglesea appear to be altogether disconnected with the glacier system of Caernarvonshire. The striæ and grooves generally range west thirty degrees south, and are probably the result of icebergs stranding and scoring the bottom as they floated from the mountains of Westmoreland.

The existence of former glaciers amongst the mountains of Westmoreland and Cumberland have been announced by Agassiz and Buckland. Both these authors, notice in several localities on the southern and eastern sides of the district, examples of scored and grooved surfaces, and the mammilar bosses which occur at Penrith and Windermere. The author thinks, however, that Dr. Buckland has extended the glacial theory frequently beyond its true limits, and has mistaken, in the valley of the Eden, Walney Island, and elsewhere, remarkable forms of drift-gravel and boulders for glacial moraines; and altogether dissents from the astounding supposition that a glacier stretched from the skirts of Shap Fell across the valley of the Eden, by means of which the granite blocks were distributed over the high table-land of Stainmore Forest, and the valley of the Tees.

The rocks of a large district surrounding the interior mountains are remarkably ice-moulded, polished, and striated, as far as the head of Morecombe Bay to the south, and the vale of the Eden to the north; and the drift, a marine boulder-clay, rises to the height of one thousand two hundred feet on the southern slopes of the hills.

Several well-marked moraines may be observed at elevations considerably below the upper limit of the drift. All those occupying this position must, in consequence, be of more recent date than this marine deposit. Of examples of this class, the most remarkable is the large terminal moraine at the lower extremity of Grisedale. This gorge, one of the most desolate and savage in Cumberland, descends from the heart of Helvellyn towards the head of Ulleswater. The rocks of porphyry which form the bottom and flanks of the valley, up to an elevation of about five hundred feet on either side, are remarkably ice-moulded, affording numerous examples of perched blocks and lateral moraines. Striations are not, however, of frequent occurrence, owing to the nature of the rocks. On descending towards the mouth of the valley, the terminal moraine arrests the attention, and appears like a congeries of large rounded hummocks, strewn with boulders, rising up the sides of the valley to about one hundred and fifty feet above the bed of the river. After the melting of the glacier, this moraine, in all probability, produced a lake. But the torrent has hewn a channel and levelled the ground over a breadth of about one hundred yards.

The position of this moraine is not more than six hundred feet above the sea-level, or two hundred and twenty feet above the Ulleswater; and it enables us to measure with exactness the dimensions of the glacier which formed it. Taken from the tarn at the head of the valley, this glacier was three miles in length, about five hundred feet in depth at its centre, and from two hundred to four hundred yards in width. On the eastern side it was bounded by a continuous and nearly vertical escarpment of bedded trap; but the western side was very irregular and indented. The phenomena of this region appear to show: first, a period when glaciers protruded far down the main valleys; secondly, an interval when the land was submerged about one thousand two hundred feet or more, during which the boulder-clay was spread over the flanks of the hills and valleys; thirdly, a period when the land had been again elevated, and glaciers extended, some distance down the minor valleys and ploughed out the drift. It was a glacier of this third period which has left the terminal moraine of Grisedale.

The glacial vestiges of the Highlands of Scotland are on a scale more grand than those of the lake district or Wales, in proportion to the greater extent and loftiness of the mountains, and their higher latitude. Ben Nevis, in lat. fifty-six deg. fifty min., attaining an elevation of four thousand three hundred and sixty-eight feet, falls only a little short of the snow line, and is said to have patches of snow all the year round in the fissures near the summit. The observations which have been recorded regarding the direction of the striæ, go to prove that the Highlands formed a *centre of dispersion*, from which the ice-streams and bergs radiated in every direction from the central range.

The southern slopes of the Grampian Hills in Angus and Forfar have received a detailed examination at the hands of Sir C. Lyell. The striations follow the lines of the main valleys south-south-east, and several fine examples of lateral and terminal moraines are mentioned. Of these the great transverse barrier of Glenairn seem to be the most remarkable. The valley of the south Esk here contracts from a mile to a half a mile in breadth, and is flanked by steep mountains. Seen from below, this barrier resembles an artificial dam two hundred feet high, with numerous hillocks on the summit. Its breadth from north to south is half a mile. Sir C. Lyell considers this to be the terminal moraine of the *receding* glacier, and considers it probable that it once banked up the river so as to form a lake, which has since been drained by the Esk having cut a channel for itself thirty feet deep on the eastern side.

The Sidlaw Hills claim particular attention on account of the examples of transported boulders which they afford. Separated by the great valley of Strathmore from the Grampian range they reach an elevation of one thousand five hundred feet. They are formed of Old Red Sandstone, and on their flanks at elevations of seven hundred and eight hundred feet are strewn blocks of gneiss and mica-slate, which have been floated across the intervening space over a distance of fifteen miles. One of these blocks on Pitscanby Hill is thirteen feet long, and seven across. This is an example, on a much smaller scale, of the erratic phenomena of the Alps, where enormous blocks have been transported across the great valley of Switzerland from the Mont Blanc range, and stranded along the flanks of the Jura hills. The *Pierre à bot*, one of these boulders, is one of the noblest monuments in the world of the transporting power of ice.

The Highlands of Perthshire have been examined along their southern watershed by Buckland and Agassiz, who detail numerous examples of glacial traces in the shape of moraines, *roches moutonnées*, striæ, and perched blocks.

The wild district of Inverness-shire and Ross-shire remain yet to be described, as far as its glacial history is concerned. From what we know of the adjoining regions, however, we may surmise that its long channel-shaped valleys and arms of the sea, stretching from the coasts far into the mountains, must have presented a series of physical conditions very similar to that of Norway, where the glaciers appear to have descended into the sea during the glacial period. The phenomena of Sutherlandshire appear to have forced such an analogy on the mind of Sir R. Murchison, when lately exploring this region. Glacial vestiges are no less marked over the rugged and inhospitable island of Skye.

Professor Agassiz is of opinion that the parallel roads of Glenroy, near the foot of Ben Nevis, are attributable to a lateral glacier having been projected across the valley, near Bridge Roy, and another across the valley of Glen Speane.

By this means glacier lakes were formed, along whose margin the stratified terraces of gravel were produced, which are now seen to line the flanks of the valley at a perfectly horizontal level through several leagues. The subsequent melting of the glaciers has entirely obliterated any traces of the agent by means of which the waters were pent up. Mr. Darwin, however, takes a different view of the subject, considering that the parallel roads are marine terraces, formed during the submergence of the land to a depth of one thousand two hundred and fifty feet, their present elevation.

Professor Agassiz and Dr. Buckland considered not only that glaciers once existed in the British Islands, but that large sheets of ice (*nappes*) covered all the surface of the districts surrounding the Highland groups. This opinion is founded on the wide extent to which unstratified gravels, perched blocks, and polished *surfaces in situ* are distributed over the districts adjacent to the centres of distribution. It is now generally allowed that floating ice, or rather *swimming* ice, has played a more important part in producing these phenomena than was supposed by the founders of the glacial theory. It is, indeed, an almost unsolved problem, how we are, in all cases, to distinguish between the effects of icebergs charged with stones scraping along the sides and bottoms of the channels through which they float, and the effects of subaërial glaciers. If of large size, and impelled by prevalent winds or currents in one general direction, they would produce polished, grooved and rounded surfaces on the rocks with which they would come in contact, and leave behind blocks and *débris* strewn so as to resemble the matter of moraines. At the same time there are several classes of objects which could *only* have been produced by subaerial glaciers, and others which bear the unmistakable impress of aqueous deposition." The great object to be accomplished is the production of maps showing the direction of the striæ, the position of the moraines, and the limits of the drift, amongst the highlands of Britain.

Remarks upon the Flint-Implements found at Amiens and Abbeville in connection with the Glacial Theory. By Adml. Wauchope. Sweeter: Penrith.

In this pamphlet Admiral Wauchope attempts to co-relate the flood of Noah with the Glacial period; and to show that the subsidence of East Florida, Newfoundland, Nova Scotia, and Labrador, by diverting the Gulf Stream, was the cause of the dispersion of icebergs over Europe. One remarkable statement is made at page 7, which it is highly desirable should be elucidated by a more particular statement of the facts,—the passage we allude to runs thus "All these events would produce a climate of equal cold with the Polar regions. This would cause a rapid, and all but total extinction of the huge Mammalia that browsed in thousands in the valleys and wooded plains. The Irish Elk was also most likely destroyed at this time; for I can prove its having been contemporaneous with man, *having seen a stone hammer sticking in the skull of one, and also the heads of others which had been perforated by the same kind of weapon.*"

Anahuac; or, Mexico and the Mexicans, Ancient and Modern. By Edw. B. Tylor. London: Longman and Co, 1861.

It is really a treat to read a book like Mr. Tylor's. Free, easy, lightly and pleasantly written, and yet containing really solid information and material.

In the spring of 1856 Mr. Tylor met another traveller, Mr. Christy, accidentally, in an omnibus at Havanna. Mr. Christy had been wandering in Cuba amongst the sugar-plantations, and copper-mines, and coffee-estates, descending into caves, and botanizing in tropical jungles; Mr. Tylor had been for the best part of the year in the United States, and had just left the live-oak forests and sugar-plantations of Louisiana. So the two travellers agreed to visit Mexico, and heartily glad will everybody be who reads the book which their adventure has produced that they did so.

It opens pleasantly with this incident, takes us on a delightful excursion to the Isle of Pines, off the Southern coast of Cuba. Then the two travellers proceed from Havana to Vera Cruz, and from Vera Cruz to Mexico. Our old English authors of the seventeenth century used to make their books as short as possible; they never said in six words what they could say properly in five, and they always tried to say what they had to say properly. They were pithy, curt, quaint, often laconic.

Mr. Tylor always says everything he has to say properly; more than this, he says it pleasantly, correctly, wittily, amusingly, *concisely*. Politics, religion, the habits of people, the characters of individuals, political economy, statistics, warfare, physical geography, geology, and scenery, are all treated with a masterly hand. As he walks through Vera Cruz, he describes the white coral-rock houses, mildewed and dismal-looking. You feel the melancholy plague-stricken look of the place; you see the great turkey-buzzards, with their bald heads and foul dingy-black plumage, sitting in compact rows on parapets of houses or churches, and thence leisurely swooping down on the offal in the streets, one after the other. Palpably the sentry, with his old flint-lock, stands at the city gate, and when you step outside you feel yourself amongst the high shifting sandhills that stretch away for miles around Vera Cruz. And so it is throughout the journey: you understand exactly what Mr. Tylor and Mr. Christy are doing; you know perfectly well who they met and what they saw; you know even exactly what time they got home to dinner, or who they dined out with, and you do not feel the least angry with Mr. Tylor for telling you. In fact, you do not know that he has told you; you have been one of the party, and of course you know what you did when you were with the travellers. Mr. Tylor is a consummate word-painter of incidents and scenery—a witty, cheerful, agreeable narrator.

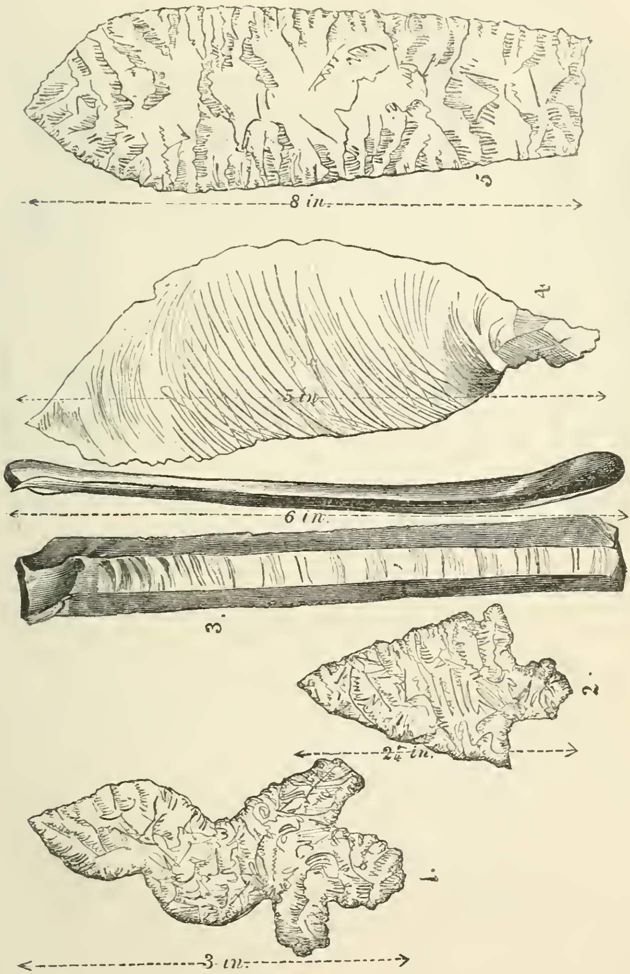
Matters geological there are plenty of in this charming volume, from shifting sandhills to lava-currents; from silver-mines to limestone-quarries. It well suits us to give a long extract from Mr. Tylor's book. The obsidian knives were not likely to be overlooked by two such well-read and observant travellers. The subject at the present time cannot fail to interest our readers.

"Soon after nightfall we got back to the English inn, and went to bed without any further event happening, except the burning of some outhouses, which we went out to see. The custom of roofing houses with pine-shingles ('tacumeniles'), and the general use of wood for building all the best houses, make fires very common here. During the few days we spent in the Real district, I find in my note-book mention of three fires which we saw. We spent the next day in resting, and in visiting the mine-works near at hand. The day after, an Englishman who had lived many years at the Real offered to take us out for a day's ride; and the Company's Administrador lent us two of his own horses, for the poor beasts from Pachuca could hardly have gone so far. The first place we visited was Penas Cargadas, the 'loaded rocks.' Riding through a thick wood of oaks and pines, we came suddenly in view of several sugar-loaf peaks, some three hundred feet high, tapering almost to a point at the top, and each one crowned with a mass of rocks which seem to have been balanced in unstable equilibrium on its point—looking as though the first puff of wind would bring them down. The pillars were of porphyritic conglomerate, which had been disintegrated and worn away by wind and rain; while the great masses resting on them, probably of solid porphyry, had been less affected by these influences. It was the most curious example of the weathering of rocks that we had ever seen. From Penas Cargadas we rode on to the farm of Guajalote, where the Company has forests, and cuts wood and burns charcoal for the mines and the refining works. Don Alejandro, the tenant of the farm, was a Scotchman, and a good fellow. He could not go on with us, for he had invited a party of neighbours to eat up a kid that had been cooked in a hole in the ground, with embers upon it, after Sandwich Island fashion. This is called a *barbacoa*—a barbecue. We should have liked to be at the feast, but time was short, so we rode on to the top of Mount Jacal, twelve thousand feet above the sea, where there was a view of mountains and valleys, and heat that was positively melting. Thence down to the Cerro de Navajas, the 'hill of knives.' It is on the sides of this hill that obsidian is found in enormous quantities. Before the conquerors introduced the use of iron, these deposits were regularly mined, and this place was the Sheffield of Mexico.

"We were curious to see all that was to be seen; for Mr. Christy's excellent collection, already large before our visit, and destined to become much larger, contained numbers of implements and weapons of this very peculiar material. Any one who does not know obsidian may imagine great masses of bottle-glass, such as our orthodox ugly wine-bottles are made of, very hard, very brittle, and—if one breaks it with any ordinary implement—going, as glass does, in every direction but the right one. We saw its resemblance to this port-wine bottle-glass in an odd way at the Ojo de Agua, where the wall of the hacienda was armed at the top, after our English fashion, apparently with bits of old bottles, which turned out to be chips of obsidian. Out of this rather unpromising stuff the Mexicans made knives, razors, arrow- and spear-heads, and other things of great beauty. I say nothing of the polished obsidian mirrors and ornaments, nor even of the curious masks of the human face that are to be seen in collections, for these were only laboriously cut and polished with jewellers' sand, to us a common-place process.

Cortes found the barbers at the great market of Tlateloleo busy shaving the natives with such razors, and he and his men had experience of other uses of the same material in the flights of obsidian-headed arrows which 'darkened the sky,' as they said, and the more deadly wooden maces stuck all over with obsidian points, and of the priests' sacrificial knives too, not long after. These things were not cut and polished, but made by chipping or cracking off pieces from a lump. This one can see by the traces of conchoidal fracture which they all show.

"The art is not wholly understood, for it perished soon after the Conquest, when iron came in; but, as far as the theory is concerned, I think I can give a tolerably satisfactory account of the process of manufacture. In the first place, the workman who makes gun-flints could probably make some of the simpler obsidian implements, which were no doubt chipped off in the same way. The section of a gun-flint, with its one side flat for sharpness and the other side ribbed for strength, is one of the characteristics of obsidian knives. That the flint knives of Scandinavia were made by chipping off strips from a mass



1. Flame-shaped arrow-head; obsidian: Teteohuacan. 2. Arrow-head; opake obsidian: Teteohuacan. 3. Knife or razor of obsidian, shown in two aspects; Mexico. 4. Leaf-shaped knife or javelin-head; obsidian; from Real del Monte. 5. Spear-head of chalcedony; one of a pair supposed to be spears of state; found in excavating for the Casa Grande, Tezcuco. (This peculiar opalescent chalcedony occurs as concretions, sometimes of large size, in the trachytic lavas of Mexico.)

is proved by the many-sided prisms occasionally found there, and particularly by that one which was discovered just where it had been worked, with the knives chipped off it lying close by, and fitting accurately into their places upon it.

Fluted prism of obsidian; the core from which flakes have been struck off.

"Now to make the case complete, we ought to find such prisms in Mexico; and accordingly, some months ago, when I examined the splendid Mexican collection of Mr. Uhde, at Heidelberg, I found one or two. No one seemed to have suspected their real nature, and they had been classed as maces, or the handles of some kind of weapon. I should say from memory that they were seven or eight inches long, and as large as one could conveniently grasp; and one or both of them, as if to remove all doubt as to what they were, had the stripping off of ribbons not carried quite round them, but leaving an intermediate strip rough. There is another point about the obsidian knives which requires confirmation. One can often see on the ends of the Scandinavian flint knives the bruise made by the blow of the hard stone with which they were knocked off. I did not think of looking to this point when at Mr. Uhde's museum, but the only obsidian knife I have seen since seems to be thus bruised at the end.

Aztec knives or razors. Long narrow flakes of obsidian, having a single face on one side, and three facets on the other.

"Once able to break his obsidian straight, the workman has got on a long way in his trade, for a large proportion of the articles he has to make are formed by planes intersecting one another in various directions. But the Mexican knives are generally not pointed, but turned up at the end, as one may bend up a druggist's spatula. This peculiar shape is not given to answer a purpose, but results from the natural fracture of the stone.

"Even then, the way of making several implements or weapons is not entirely clear. We got several obsidian maces or lance-heads—one about ten inches long—which were taper from base to point, and covered with taper flutings; and there are other things which present great difficulties. I have heard on good authority that somewhere in Peru the Indians still have a way of working obsidian by laying a bone wedge on the surface of a piece, and tapping it till the stone cracks. Such a process may have been used in Mexico.

We may see in museums beautiful little articles made in this intractable material, such as the mirrors and masks I have mentioned, and even rings and cups. But, as I have said, these are mere lapidaries' work.

The situation of the mines was picturesque; grand hills of porphyritic rock, and pine-forest everywhere. Not far off is the broad track of a hurricane, which had walked through it for miles, knocking the great trees down like ninepins, and leaving them to rot there. The vegetation gave evident proof of a severe climate; and yet the heat and glare of the sun were more intolerable than we had ever felt it in the region of sugar-canes and bananas. About here, some of the trachytic porphyry which forms the substance of the hills had happened to have cooled, under suitable conditions, from the molten state into a sort of slag or volcanic glass, which is the obsidian in question; and, in places, this vitreous lava—from one layer having flowed over another which was already cool—was regularly stratified.

"The mines were mere wells, not very deep; with horizontal workings into the obsidian, where it was very good and in thick layers. Round about were heaps of fragments, hundreds of tons of them; and it was clear, from the shape of these, that some of the manufacturing was done on the spot. There had been great numbers of pits worked; and it was from these "minillas," little mines, as they are called, that we first got an idea how important an element this obsidian was in the old Aztec civilization. In excursions made since, we travelled over whole districts in the plains, where fragments of these arrows and knives were to be found, literally at every step, mixed with morsels of pottery, and here and there a little clay idol. Among the heaps of fragments were many that had become weathered on the upper side, and had a remarkable lustre, like silver. Obsidian is called *bizcli* by the Indians, and the silvery sort is known as *bizcli platera*. They often find bits of it in the fields; and go with great secrecy and mystery to Mr. Bell, or some other authority in mining matters, and confide to him their discovery of a silver mine. They go away angry and unconvinced when told what their silver really is; and generally come to the conclusion that he is deceiving them, with a view of throwing them off the scent, that he may find the place himself, and cheat them of their share of the profits—just what their own miserable morbid cunning would lead them to do under such circumstances.

"The family-likeness that exists among the stone tools and weapons found in so many parts of the world is very remarkable. The flint-arrows of North America, such as Mr. Longfellow's arrow-maker used to work at in the land of the Dacotahs, and which, in the wild northern states of Mexico, the Apaches and Comanches use to this day, might be easily mistaken for the weapons of our British ancestors, dug up on the banks of the Thames. It is true that the finish of the Mexican obsidian implements far exceeds that of the chipped flint and agate weapons of Scandinavia, and still more those of England, Switzerland, and Italy, where they are dug up in such quantities, in deposits of alluvial soil, and in bone-caves in the limestone rocks. But this higher finish we may attribute partly to the superiority of the material; for the Mexicans also used flint to some extent, and their flint weapons are as hard to distinguish by inspection as those from other parts of the world. We may reasonably suppose, moreover, that the skill of the Mexican artificer increased when he found a better material than flint to work upon. Be this as it may, an inspection of any good collection of such articles shows the much higher finish of the obsidian implements than of those of flint, agate, and rock-crystal. They say there is an ingenious artist who makes flint arrow-heads and stone axes for the benefit of English antiquarians, and earns good profits by it. I should like to give him an order for ribbed obsidian razors and spear-heads; I don't think he would make much of them.

Mexican arrow-heads of obsidian.

"The wonderful similarity of character among the stone weapons found in different parts of the world has often been used by ethnologists as a means of supporting the theory that this and other arts were carried over the world by tribes migrating from one common centre of creation of the human species.

Aztec knife of chalcedony, mounted on a wooden handle, which is shaped like a human figure, with its face appearing through an eagle-head mask, and has been inlaid with mosaic work of malachite, shell, and turquoise. Length 12¼ inches.

The argument has not much weight, and a larger view of the subject quite supersedes it.

"We may put the question in this way. In Asia and in Europe the use of stone tools and weapons has always characterized a very low state of civilization; and such implements are only found among savage tribes living by the chase, or just beginning to cultivate the ground, and to emerge from the condition of mere barbarians. Now, if the Mexicans got their civilization from Europe, it must have been from some people unacquainted with the use of iron, if not of bronze. Iron abounds in Mexico, not only in the state of ore, but occurring nearly pure in aerolites of great size, as at Cholula, and at Zacatecas, not far from the great ruins there; so that the only reason for their not using it must have been ignorance of its qualities.

"The Arabian Nights' story of the mountain which consisted of a single loadstone finds its literal fulfilment in Mexico. Not far from Huetamo, on the road towards the Pacific, there is a conical hill composed entirely of magnetic iron-ore. The blacksmiths in the neighbourhood, with no other apparatus than their common forges, make it directly into wrought iron, which they use for all ordinary purposes.

"Now, in supposing civilization to be transmitted from one country to another, we must measure it by the height of its lowest point, as we measure the strength of a chain by the strength of the weakest link. The only civilization that the Mexicans can have received from the Old World must have been from some people whose cutting implements were of sharp stone, consequently, as we must conclude by analogy, some very barbarous and ignorant tribe.

"From this point we must admit that the inhabitants of Mexico raised themselves, independently, to the extraordinary degree of culture which distinguished them when Europeans first became aware of their existence. The curious distribution of their knowledge shows plainly that they found it for themselves, and did not receive it by transmission. We find a wonderful acquaintance with astronomy, even to such details as the real cause of eclipses, and the length of the year given by intercalations of surprising accuracy; and, at the same time, no knowledge whatever of the art of writing alphabetically, for their hieroglyphics are nothing but suggestive pictures. They had carried the art of gardening to a high degree of perfection; but, though there were two kinds of ox, and the buffalo at no great distance from them in the countries they had already passed through in their migration from the north, they had no idea of the employment of beasts of burden, nor of the use of milk.

They were a great trading people, and had money of several kinds in general use, but the art of weighing was utterly unknown to them; while, on the other hand, the Peruvians habitually used scales and weights, but had no idea of the use of money.

"To return to the stone knives. The Mexicans may very well have invented the art themselves, as they did so many others; or they may have received it from the Old World. The things themselves prove nothing either way.

"The real proof of their having, at some early period, communicated with inhabitants of Europe or Asia rests upon the traditions current among them, which are recorded by the early historians, and confirmed the Aztec picture-writings; and upon several extraordinary coincidences in the signs used by them in reckoning astronomical cycles. Further on I shall allude to these traditions.

"On the whole, the most probable view of the origin of the Mexican tribes seems to be the one ordinarily held, that they really came from the Old World, bringing with them several legends, evidently the same as the histories recorded in the book of Genesis. This must have been, however, at a time when they were quite a barbarous, nomadic tribe; and we must regard their civilization as of independent and far later growth.

"We rode back through the woods to Guajalote, where the Mexican cook had made us a feast after the manner of the country, and from her experience of foreigners had learnt to temper the chilé to our susceptible throats. Decidedly the Mexicans are not without ideas in the matter of cookery. We stayed talking with the hospitable Don Alejandro and his sister till it was all but dark, and then rode back to the Real, admiring the fire-flies that were darting about by thousands, and listening to our companion's stories, which turned on robberies and murders—as stories are apt to do in wild places after dark. But, save an escape from being robbed some twenty years back, and the history of an Indian who was murdered just here by some of his own people, for a few shillings he was taking home, our friend had not much reason to give for the two huge horse-pistols he carried, ready for action. His story of the death of a German engineer in these parts is worth recording here. He was riding home one dark night with a companion; and, trusting to his knowledge of the country, tried a short cut through the woods, among the old open mines near the Regla road. They had quite passed all the dangerous places, he thought, so he gave his horse the spur, and plunged sheer down a shaft, hundreds of feet deep. His friend pulled up in time, and got home safely."

From this interesting subject we pass on to a discourse on numerals and counting; then to the siege and capitulation of Puebla; to miracles, rival virgins, Indian canoes, water-snakes, salt and salt-pans, fried flies'-eggs, Aztec pictures, the mammoth bones in the Mexican museum, bull-lazoing and cock-fighting, gambling and fortunate miners, travelling companions and Mexicans who live by their wits, artificial lightning, the future destinies of Mexico, *cum multis aliis*, which are, as the puffing advertisers say, "too numerous to mention." With them we do not meddle; luckily for us, our province is confined to the geological: we do not say all we could say about that; but if we were tempted out of our course, eight pages would not suffice for this review.

We linger only to add a valuable note which Mr. Tylor gives us in an appendix, on the manufacture of obsidian knives.

"Some of the old Spanish writers on Mexico give a tolerably full account of the manner in which the obsidian knives, &c., were made by the Aztecs. It will be seen that it only modifies in one particular the theory we had formed by mere inspection as to the way in which these objects were made, which is given at p. 97; that is, they were cracked off by pressure, and not, as we conjectured, by a blow of some hard substance.

Torquemada (*Monarquia Indiana, Seville*, 1616), says (free translation):

"'They had, and still have, workmen who make knives of a certain black stone or flint, which it is a most wonderful and admirable thing to see them make out of the stone; and the ingenuity which invented this art is much to be praised. They are made and got out of the stone (if one can explain it) in this manner. One of these Indian workmen sits down upon the ground, and takes a piece of this black stone, which is like jet, and hard as flint, and is a stone which might be called precious, more beautiful and brilliant than alabaster or jasper, so much so that of it are made tablets and mirrors. The piece they take is about eight inches long or rather more, and as thick as one's leg or rather less, and cylindrical; they have a stick as large as the shaft of a lance, and three cubits or rather more in length; and at the end of it they fasten firmly another piece of wood, eight inches long, to give more weight to this part; then, pressing their naked feet together, they hold the stone as with a pair of pincers or the vice of a carpenter's bench. They take the stick, which is cut off smooth at the end, with both hands, and set it well home against the edge of the front of the stone *(y ponenlo acesar con el canto de la frente de la piedra)* which also is cut smooth in that part; and then they press it against their breast, and with the force of the pressure there flies off a knife, with its point, and edge on each side, as neatly as if one were to make them of a turnip with a sharp knife, or of iron in the fire. Then they sharpen it on a stone, using a hone to give it a very fine edge; and in a very short time these workmen will make more than twenty knives in the aforesaid manner. They come out of the same shape as our barbers' lancets, except that they have a rib up the middle, and have a slight graceful curve towards the point. They will cut and shave the hair the first time they are used, at the first cut nearly as well as a steel razor, but they lose their edge at the second cut; and so, to finish shaving one's beard or hair, one after another has to be used; though indeed they are cheap, and spoiling them is of no consequence. Many Spaniards, both regular and secular clergy, have been shaved with them, especially at the beginning of the colonization of these realms, when there was no such abundance as now of the necessary instruments, and people who gain their livelihood by practising this occupation. But I conclude by saying that it is an admirable thing to see them made, and no small argument for the capacity of the men who found out such an invention.' "

Now we take our leave of "Anahuac;" we have read it from beginning to end and have been delighted with it. Our readers will be the same if they buy it and read it right through as we have done.

We have to thank Mr. Tylor for the use of some of the excellent woodcuts with which his book is copiously illustrated.

Primeval Man. By the Rev. Dr. Anderson, F.G.S. Edinburgh: Paton and Ritchie, 1861.

This small Pamphlet, a report and address to the Graduates' Association at St. Andrew's, has been sent to us by its author, the Rev. Dr. Anderson of Dura Den, who takes views on the subject of flint-implements and their bearings on the question of the great antiquity of man like those expressed by M. Robert in his late correspondence with M. Boucher de Perthes, namely, that there had been much commingling by diluvial or torrential action of the bones and debris embedded in the more ancient pleistocene beds, with more recent remains and more modern sediments and deposits.

Geological changes are daily falling within our own observations, and scarcely a year elapses without something occurring worthy to be noticed. The Murrayshire floods of 1829; then in the spring of 1859, at the breaking up of the ice in the river Spey and its tributaries, and the vast accumulation of sand and gravel near the junction of the Eden with the Ceres Burn, are quoted by Dr. Anderson who deduces from these and similar modern instances that the mere *position* of the beds of gravel and silt in which the flint weapons are found does not necessarialy determine their time, or even relative ages one with another. Many of them may not be in their original places, but have been shifted and carried to other localities, either suddenly by river-flooding, or slowly and gradually by the eroding action of rains and runlets of streams,

Although these opinions are not in strict accordance with our own, we are always ready to concede a portion of our pages in stating the opposing views of others, whenever those views have any merit.

We are sorry, however, that Dr. Anderson should have misinterpreted and mis-stated some of our thoughts expressed in a former volume of "The Geologist," but as we feel quite sure this was not intentional on his part, we refrain from further comment on that subject.

THE GEOLOGIST.

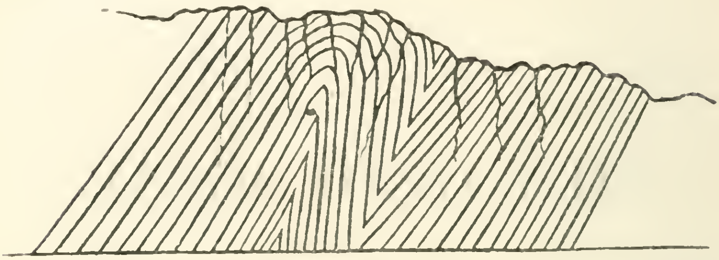
JULY, 1861.

ON METALLIFEROUS SADDLES.

By Dr. R. N. Rubidge, of Port Elizabeth, South Africa.

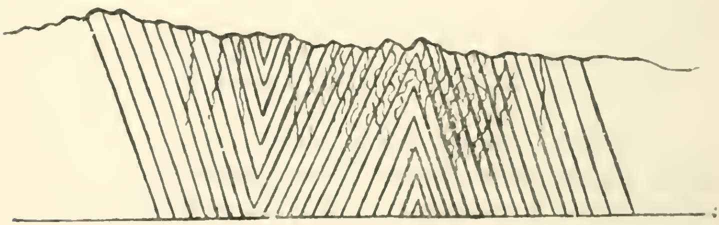
In the number of your journal for October, 1860, I read with great interest a paper by Dr. Watson "On the Metalliferous Saddles of Derbyshire and Staffordshire." The Doctor says that, though well known to the miners, he believes these saddles have not hitherto been described by any geologist. If he will refer to the Journal of the Geol. Soc., 1857, p. 233, he will find a paper "On the Mines of Namaqualand," in which I think he will recognise a description of these deposits under the name of "metallic axes." With such modifications as the difference in the strata and their metallic contents requires, his description would nearly apply to what I said.

The strata in which my axes occur are gneiss and gneiss-granite with occasional beds of magnesian and micaceous rock at Springbok Vontein and Concordia, and micaceous and calcareous rock, with gneiss at Kodas. The saddles (a better name than mine) in all the productive mines were folds in the strata, with fissures of various sizes and directions intersecting them. The one was in some cases more abundant in the planes corresponding to the original bedding of the rock: this was strikingly the case at Concordia, where the main dip was north and the disturbed one south—the strike of the rocks being nearly east and west. (Sec. 1 and 2).



Dip South. Dip North. Dip South.

Fig. 1.—Spring Bok Vontein.



Dip North.

Fig. 2.—Concordia.

The ore is chiefly copper, with a good deal of iron, a little molybdenum (sulphuret), an occasional film of gold, and in one instance a lump of tungstate of lime. Oxides, silicates, and carbonates occupied the fissures and the upper parts of the pipe-veins, those, viz., where the surface-action was greater. Black, purple, and yellow sulphurets succeeded at first in good quantities; but lower in the excavation the gneiss became mere felspathic, less fissured, and at length assumed the form of a felspathic granite, in which only specks of pyrites were observable here and there. Meeting these saddles, whose anticlinal line coincided, or nearly did so, with the strike of the rocks, were twists of the strata, figs. 3 and 4, crossing the strike at various angles, one of which, a horizontal section, appeared on the surface near its junction with the metallic saddle of Koperberg, and had the appearance in fig. 3. The points *a* and *c*, were not three feet apart; the line *f. g.*, about an inch thick, was micaceous rock with large crystals of felspar. The richest deposits of ore seemed to me to occur at

Line of Strike.

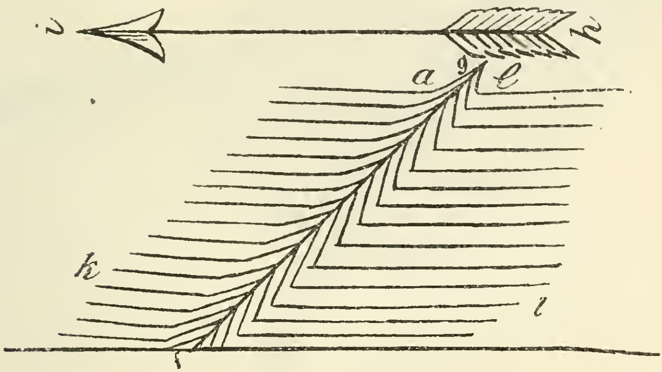


Fig. 3.—Koperberg.
h i, direction of the metallic axis; *k l*, strike of the rocks; dip towards *h i*.

spots on the saddles or axes where one or more of these twists met them. There was generally no metal in the twists. The axes too were traceable for miles through the country, but were only metalliferous, to any considerable extent, at intervals. Thus, I believe the mines of Springbok Vontein and Koperberg were on the same run—a good section of which was visible on the side of a ravine crossing it nearly at right angles near Koperberg. This showed that these disturbances were not produced by, nor essentially connected with, granite. The meeting of a twist with the saddle of Koperberg I have mentioned. I believe more than one crossed that of Springbok Vontein, though the surface was so decomposed and so scarred and fissured in various directions that it was impossible to make it out clearly. This mine had not been worked to any great depth when I visited it. The observations on the succession of ores, though I believe it applies equally to this, was made at Concordia and other places.

At Nababeel, a spot which has not produced so much ore as its appearance promised, was observed the structure shown in fig. 4.

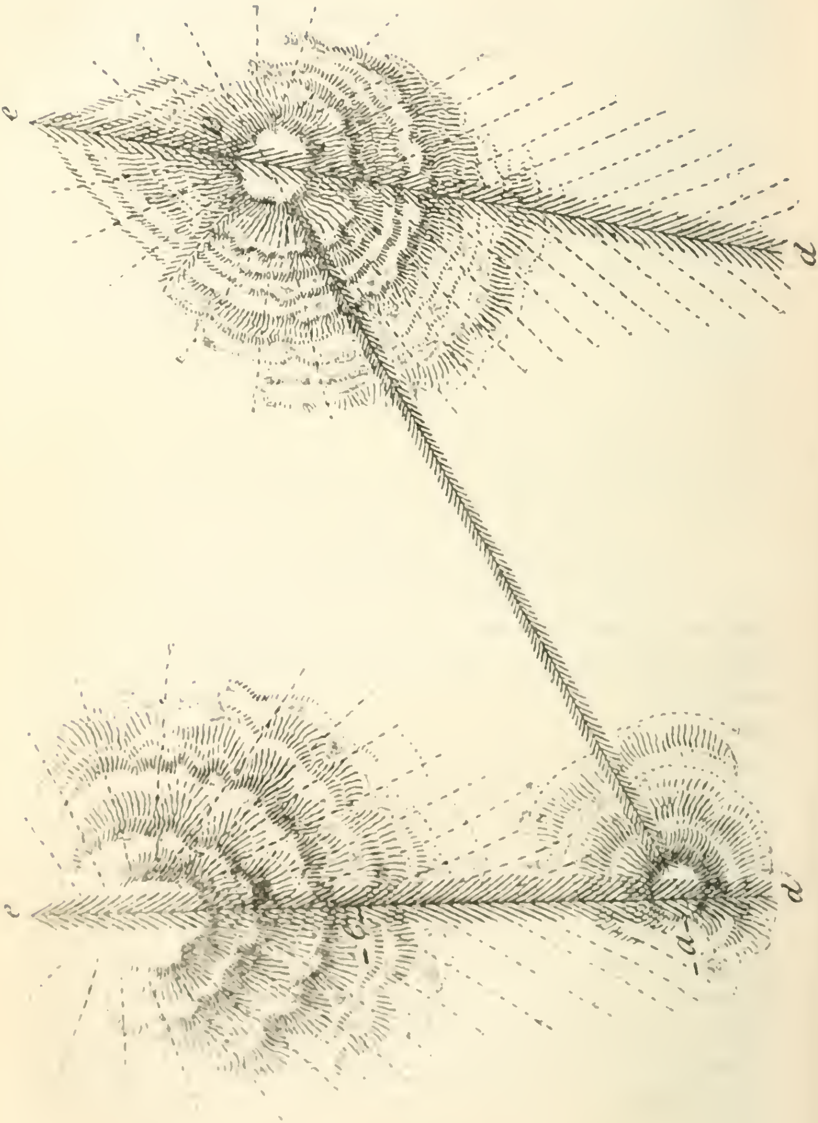


Fig. 4. Nalmbeel.

a, ore; *B*, indications of ore; *C*, traces of ore; *d e*, metallic axis. The strike of the country takes the same direction, or nearly so.

When the saddles were traced down to any considerable depth the gneiss seemed gradually to lose its laminated character, and assume the form of a highly felspathic granite, which lower down lost all traces of metal.

It was evident to me, as I stated at the time, that the deposits of ore were due to the surface-actions of water, with what aid from electro-magnetic agency I know not. Some of the rocks acted strongly on the magnetic needle; but, as most of them contained iron, it might have been owing to that, though all the ores that I tried in one or two mines had no such effect.

I believe that what I then stated still holds good—that at whatever depth (and it varied considerably) surface-action ceased, the ore disappeared. I mentioned several circumstances to show that even the less soluble ores were acted upon by the water of the district, and that in the case of Van der Stell's mine the surface of the excavation has been coated with silicate of copper by permeation through the solid gneiss rock since his time,—1680, I believe.

Your interesting periodical, though ordered through an agent as soon as I heard of it, only reached me last month. I find that views which I entertained on the nature of granite years ago are fast gaining ground on the continent. I wrote about this to members and officers of the Geological Society at intervals for several years; and, though I did so with the diffidence of one whose position did not entitle him to hold an opinion adverse to those of the leaders in science, I believe that I said enough to show that, if the igneous theory of granite is abandoned by most geologists ere twenty years elapses, as I believe it will be, I was among the first to give it up, and to show good reasons for doing so. That if the metamorphic theory was true, as applies to gneiss, mica-schist, &c., it was equally true of granite, syenite, and greenstone, I felt quite sure in 1855. That clay-slate passed quietly into mica-schist, chlorite-schist, gneiss, &c., without eruptive rock of any kind, I stated as early. That rocks were changed into quartzite by surface-infiltration, I wrote as my opinion to Sir R. Murchison in the same year. In 1857 I showed good reason to believe that the oversight of this fact had led to great error as to the super-position of our strata. Since then I have *proved* that strata set down as primitive and separated from the

Devonian on the evidence of their mutual relation with horizontal and inclined quartzite are all of one formation; all contain the same fossils, and all have the same relation to the quartzite in different localities. See Quart. Journ. Geol. Soc., vol. xv, p. 196, &c.

CORRESPONDENCE.

DIFFICULTIES OF DARWINISM.

SIR,—In the article on Mr. Darwin's theory that I contributed to your magazine in April and May last, I contented myself with stating the scientific arguments both for and against it, as they presented themselves to me. I did not touch on any of the points connected with theology, as I mistrusted my ability to deal properly with them; and now, if Mr. Grindley's attack had been directed against myself alone, I should not have troubled you with any remarks on the subject; but as he has stated that this theory is opposed to the truths of Revealed Religion, I feel that I ought to do my best to show that I believe such not to be the case.

In his first paragraph Mr. Grindley says that "its direct effect would be to shut the Creator out of the world of His own creation, and to set up instead what the Rev. Baden Powell calls the 'self-evolving powers of nature.'" Now in this I cannot agree with him. They who speak of this theory as "shutting out the Creator from the world of His own creation," seem to imagine that its advocates dispense with the necessity of a Creator altogether; and they talk of the "theory of creation and the "theory of development" as if the one were the exact contrary of the other. But the theory of development, or of natural selection, is merely a theory of *the way in which the Creator has carried on His work of creation;* not a denial of a Creator, nor of creation. I cannot understand why natural selection has been so often mistaken for a cause, when it is evidently the effect of the "struggle for life" acting on variations in species, which variations are the effects of an unknown law ordained and guided, without doubt, by an Intelligent Cause "on a preconceived and definite plan." I have neither time nor space to go into any of the proofs now, but I must refer Mr. Grindley to a most able pamphlet called "Natural Selection not inconsistent with Natural Theology," by Dr. Asa Gray, published in the "Atlantic Monthly" for July, August, and October, and reprinted in England by Trübner and Co., 60, Paternoster-row, which I would also recommend to your other readers who take an interest in the subject.

The second paragraph requires no notice. I leave it to your readers to judge whether satisfactory answers have been, or can be, given to most of the statements by any other hypothesis.

With reference to the third paragraph, I must protest against Mr. Grindley saying that I profess "to have answered the principal objections to the Darwinian theory." If he looks at my article again, he will see that I merely state the objections and the answers *that have been given to them* (the answer to No. 4 being the only original one), and leave it an open question. It is not until I have stated the arguments in favour of the theory that I say that, on the whole, the evidence seems to be in favour of it. He also puts four queries to me, upon which I must make a few remarks.

1. It seems that he had only read one-half of my paper when he wrote this. He has by this time, I hope, found my opinion on it in the second half.

2. I must confess that I do not understand what Mr. Grindley means by "no specimen in the transition state has ever been found;" although it cannot be a mistake, for he uses the same words again.

According to Mr. Darwin's theory, all species are in a transition state. Mr. Grindley cannot have formed very clear ideas on the subject, if he thinks that we ought to find animals of half one species and half another, like mermen or centaurs. If he means connecting links between species, any elementary work on natural history or palæontology will point out many to him.

3. I have not the slightest doubt but that Professor Owen is quite right, and that it is a fact that "no *known* cause of change productive of the varieties of mammalian species could operate in altering the size, the shape, &c., &c.;" but I do not see how Mr. Grindley obtains from it the conclusion which he implies, viz., that therefore the variations could not have taken place. We do not *know* the causes of many things. Besides, it is not at all necessary to Mr. Darwin's theory to suppose that man has been developed from the gorilla; on the contrary, as they are recent species, the parent stock of both is most likely extinct.

4. Mr. Darwin does not pretend to adduce direct evidence of one species changing into another; although, when we see two forms so different as to have been at first classed by all naturalists as distinct species, and afterwards, on the discovery of connecting links, obliged to be referred to one and the same, I think that we might fairly take that as an instance of one species having passed into another. For even if one of them should not be a lineal descendant of the other, yet, as they are allowed to be of the same species, they must have had a common progenitor, which could not have been like them both. Among species, I need hardly say, instances of this kind are innumerable, and in the case of the foraminifera, Messrs. Carpenter, Jones, and Parker have been obliged to acknowledge that many forms, previously considered not only as of different species, but as of different genera and even orders, "must, in all probability, have had a common origin."

Mr. Grindley says that, until direct evidence can be produced, it is no "true physical law," but a "mere dream." I am sorry to have to refer him again to my paper, but, if he will take the trouble to look, he will see that I do not say that it is a true physical law, but that at present it must be considered as a very probable hypothesis. A probable hypothesis only becomes a true theory when the probabilities in its favour amount to certainty; and it then becomes one even if no direct proof can be given. The first law of motion itself has not been, and cannot be, proved by direct experiment; yet who disbelieves it? The theory of the undulation of light, and even the very existence of ether upon which it depends, cannot be proved directly, yet it is believed to be true on account of the immense number of phenomena that it explains; and, although I do not mean to say that the proof of the transmutation of species is at all equal to the proof of the undulatory theory of light, still it easily explains a great number of phenomena.

With regard to paragraphs 4, 5, and 6, I am willing to admit that Adam may have been "a noble specimen of man, and Eve a soft Circassian beauty," though I do not know that "the Scriptures of Truth" anywhere "assert" this; but I am sorry to see Mr. Grindley wasting the best and most eloquent parts of his letter on shadows. No advocate of the Darwinian theory, to the best of my knowledge, ever said that "the mental and moral powers of man" were developed from the instincts of the lower animals. On the contrary, I see many reasons for believing that, when the time was come that man was fitted to receive them, they were given him by a special interposition of the same power that created all things. The Rev. J. Kenrick, in his essay on Primæval History, published in 1846, has remarked that "it is impossible to define the time which he (man) occupied in advancing from his primæval condition to that in which he appears at the commencement of history;" and we must remember that it is the mental qualifications of man, and not the physical strength of his body, which gives him "dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth." The only argument, as far as I know, against this view is that there are races of men, as the Zulu Caffres, who seem to have no more sense of right and wrong than the beasts, and no belief in or knowledge of a God.

As for Mr. Grindley's indignation at the "humility" of those "who would link themselves with brutes," I feel no more disgraced in supposing that our present bodies are the noblest result of creation's work, perfected through countless ages, and through countless forms, than in the fact that our actual bodies, in which we are now living, are formed of the food we eat, which, in its turn, must shortly before have existed only as inorganic elements—as, in fact, "the dust of the ground."

With regard to the last paragraph, I stated in my paper that there is nothing like a total absence of intermediate forms in the geological record; and if Mr. Grindley does not mean them by his "species in a transition state," I do not know what he does mean. I do not remember where Sir C. Lyell "proves the theory that *all the great classes of organic life* were created *at once*," and I do not think that he is likely ever to have attempted to do so; but I have never seen the third edition of his "Principles." In the ninth chapter of the ninth edition, he shows that, owing to the great imperfection of the geological record, "we must not too hastily infer that the highest class of vertebrated animals did not exist in remoter ages," and also that we ought to be on our guard against "taking for granted that the date of creation of any family of animals or plants in past time coincides with the age of the oldest stratified rock in which the geologist has detected its remains," and I suppose it is to this that Mr. Grindley refers. In my paper I said that I thought the geological argument was in favour of Mr. Darwin's theory, because all known fossils are intermediate to living forms—that is to say, they fall naturally into the modern classification, and help to fill up the gaps in it, and because, as a general rule, the older a form is, the more it differs from living ones. I cannot, therefore, imagine what made Mr. Grindley think that my conclusions were opposite to those of Sir C. Lyell, or that they were drawn from the same facts; but as he says that he only received his copy of the "Geologist" on the morning that he wrote his letter, I dare say he read it rather hastily.

I do not wish to take up more of your space than I can help, or I would make some remarks on the numerous inconsistencies and absurdities in Mr. Grindley's letter; such as "theories which now-a-days take the place of facts." Compare "to bring forward a number of isolated statements is simply absurd" with "this single statement is weighty enough to decide the whole question." .."If it cannot trace the sequence of the development of the mammal into man." "But if they cannot point to the possession of a moral nature beyond the pale of humanity, then I contend that their whole theory fails," &c., &c. But as none of these bear directly on the question at issue, I leave them for the amusement of your readers.

Yours truly,

Staff College, June 7. F. W. Hutton.

DEER'S HORNS IN BRIXHAM CAVERN.

Dear Sir,—The important communication which appeared in the last (June) number of the "Geologist," from your correspondent Mr. Drake, contains the following passage, which seems to require a little attention, namely: "The arrow-head found entangled in the horns of the stag by Mr. Pengelly, at Brixham, was vast in importance." I cannot understand how the idea of an "arrow-head" being found so "entangled" has got abroad. A similar passage occurs in Professor Ansted's "Geological Gossip," and is possibly the original of Mr. Drake's.

Be this as it may, it is certain that no arrow-head, or worked flint, or other stone of any kind was so situated. The antler of the rein-deer was found lying *on* the floor or cake of stalagmite which covered the bed of bone-earth with all its contents, and *all* the worked flints lay at the base of this bone-bed, and therefore at a considerably lower level than the antler.

The relics of the cave mammals, with the evidences of man's existence and (as I believe) high antiquity, had all been deposited and hermetically sealed up before the introduction into the cavern of that fine relic of the rein-deer.

So far as Mr. Drake's inference is concerned, this correction is unimportant, but it seems right to prevent, if possible, erroneous statements respecting Brixham Cavern from becoming current, especially as no authorized report on it has yet been given to the world.

I am yours, &c.,

Lamorna, Torquay, June 4. W. PENGELLY.

FOREIGN CORRESPONDENCE.

M. GAUDRY has communicated another interesting paper on his researches in Greece, in which he states that, although his researches in 1855 furnished him with the remains of a great number of ruminants, they never brought to light any tooth or skull belonging to one of the goat tribe. So in a note which M. Lartet and himself laid before the Academy in 1856, they stated their opinion that the amalthée might be an antelope. At the present time M. Gaudry possesses eighteen skulls, and most of them have their posterior part whole, two among them being furnished with their teeth and the bony axes of the horns. These fossils confirm the supposition that the amalthée is not a goat, but an antelope. M. Owen says that the grinders of the antelope are distinguished from those of the goat in not having interlobular columns, their covering of enamel being longer, and the external surface of the superior grinders having the furrows more marked and the depressions not so plainly limited by straight longitudinal borders. M. Gaudry has remarked also that with goats the superior front grinders are cut at right angles, instead of being rounded and sinuous as with antelopes ; it seems that they are halves separated from the back grinders. They have not any distinct tops like those of antelopes, so much so that one cannot mark the part where the enamel begins upon the shaft. These characters give the front grinders of the goat, seen on the external surface, a look which reminds one a little of the teeth of a horse. In goats the three front grinders are very straight, the space which they occupy is far from being the third of the total length of the series of grinders, whilst in the antelopes they attain, and sometimes go beyond, the third of that length. It is true that these various characters are subject to exceptions, but at least they are more constant than those furnished by the horns, and certainly they are of greater generic value. The amalthée has not any of those characteristics enumerated as peculiar to goats; it has, on the contrary, those belonging to the antelope.

The teeth of the upper jaw bone, and particularly of the lower one, have the interlobular tubercules jutting out, becoming in some specimens real columns. The principal part of the skull does not recede behind the horns as does that of the goat. It is straight and massive, and forms a right angle with the occiput. As there is no existing sub-genus of antelope in which this could be placed, the name of tragoceras (τράγος goat, and χέρας horn) has been proposed for it, and *Trag. Amalthæus* in the name M. Gaudry would give the above described species.

In a small skull of an antelope, still furnished with its teeth and the bony axes of its horns, the extremity of the nasal and intermaxillary bone is still preserved. This discovery allows him to determine a great many axes which, up to the present time, had been found separated, and which M. Wagner had included under the name of *Antelope brevicornis*. The skull discovered can be classed in the sub-genus gazelle. It resembles the general form of the head of the common gazelle in the direction of its horns, their point of insertion, their spread and the orbital depressions at their base.

Some specimens of the *Antelope Lindermayeri* have also been discovered, which much resemble the *Oreas canna*, though differing in detail. M. Gaudry, therefore, proposes to name it *Palaeoreas Lindermayeri*.

Entire skulls of all the antelopes found at Pikermi are now in the possession of M. Gaudry. An undescribed one, much resembling the sub-genus *Antidorcas* has just been forwarded to him.

Two skulls, found in 1855, resembling *Tragoceras amalthæus* appear sufficiently distinct to constitute another species, which M. Gaudry names *Trag. Valenciennesi*, in honour of the distinguished savant to whose good counsel in palæontology M. Gaudry owes so much.

On Flint Implements. By MM. Boucher de Perthes and Robert.

In our number for May we gave a *résumé* of a paper by M. Robert on the substances worked by the primitive Gauls, in which he stated his opinions on the age of the Celts, &c., which have been discovered in several parts of France.

M. Boucher de Perthes, in a memoir read before the Paris Academy of Sciences, replies to this paper, and, having arrived at a very different result from M. Robert on the subject, proceeds to state the grounds for so doing.

In the first place he says, that recent bones have never been found at St. Acheul, Abbeville, or indeed in any deposit of diluvium mixed with fossil bones. This statement differs *toto cœlo* from that of M. Robert, to which we again refer our readers.

Secondly, he states that M. Robert is in error in saying that the bones of extinct species of elephants, rhinoceros, &c., found at St. Acheul and Meuchecourt, are much worn and water-rolled, and that those of the horse, aurochs, &c., are not; they are very rarely water-rolled, and those that are belong as often to existing species as to extinct ones. (See Cuvier "Oss. Foss., Bœufs Fossiles," tome iv., p. 162, edition 4to, 1823.) No palæontologist, since Cuvier, has endeavoured to draw a chronological distinction between the bones of the elephant, rhinoceros, horse, stag, and aurochs, mixed pell-mell in the same beds of diluvium, from which the hatchets and worked flints have since been obtained. The bones found at the above-mentioned places bear no comparison, either in colour or weight, with those of the turbaries or those belonging to existing domestic animals.

M. B. de Perthes then asks, why the flood, which destroyed the habitations of man, and washed the bones of extinct species from the diluvium to mix with the drowning carcases of animals, did not wash up the bones of man also, and, supposing they burned the dead, the urns which contained the calcined dust? Why, too, does not the resulting bed contain remains of dwellings, bricks, glass, metals, or indeed of any index of the first stage of civilization presented by the lacustrine deposits of Switzerland?

M. B. de Perthes then argues on the age of the flints as shown by their own colour, &c., and by the accompanying beds always being exactly similar, and then proceeds to ask, if the men of those days inhabited the deep vallies and were surprised by inundations which washed away their habitations and all they contained, how it is that these hatchets have been found more than thirty metres above the level of the vallies, found, too, associated with elephantine remains; and how is it, again, that only these have been so carried? He concludes his paper in these words:—"If the diluvium where the bones and hatchets have been found, is not the veritable diluvium, where is it? Cuvier, Brongniart, M. Elie de Beaumont himself, and more recently Verneuil, Lartet, Collomb, Prestwich, Lyell, and Murchison, have been strangely deceived, since they have mistaken that for it; and stranger still, have recognized as virgin soil that which, according to M. Robert, is but a modern twice deposited alluvium.

To the above communication of M. Boucher de Perthes, M. Robert has replied at a subsequent date, to the following effect.

He considers the most serious objection raised by M. de Perthes to be contained in the following question:—"If the men of that time inhabited the deep valleys and were there surprised by the flood which washed away their dwellings and all they contained, hatchets among the rest, how comes it that these hatchets are found thirty mètres above the level of those valleys, and how have they been carried there with the bones of elephants, &c.?"

M. Robert submits the following explanation:—

"At the time of the first appearance of man in Europe, many ages after that great cataclysm which destroyed every breathing thing on the earth, at least in our hemisphere, and with a violence sufficiently powerful to snatch from the ocean the immense body of a whale and deposit it in the Paris basin, where now is situate the Faubourg Saint Germain. The valleys were filled with materials prepared by this grand bouleversement, and spread confusedly over all the continent.

For a long time they seem to have been occupied rather by chains of lakes and marshes than by rivers. The first inhabitants of these countries established themselves near these lakes, and when the inundations came, as come they do in the present day in the same valleys, they naturally left all they cared for least, such as hatchets, and sought the upland. Their burial grounds always having been put out of the reach of these overflows, one never finds human bones mixed with the bones of other animals. As to the vases, which according to M. Boucher de Perthes contained the ashes of their dead, and might have been carried away by the waters, one can easily understand why no vestiges are to be found as they were simply dried in the sun, and would not stand the slightest shock without being reduced to powder."

Thus it is that objects of human industry are mixed up in the alluvium with the remains of animals of extinct and even new species; some more or less rolled, others scarcely: and if some dépôts exist above the present level of the rivers, it is that those rivers have hewn out for themselves a bed deeper and deeper, year by year, in the deposits with which they were in the first instance surrounded.

M. Robert adds that these valleys have not been filled up very violently, for most of the flint-implements found in the valley of the Somme have a very new look about them which does not admit of their having been much water-worn, although they are side by side with rolled stones from which they might have been cut.

In alluding to the bone-caves in which human remains are associated with ancient pottery and the bones of extinct animals, M. Robert refers to the labours of M. Desnoyers, who has pretty well proved that the caverns in which this singular association is offered were inhabited by the Celts, or used as a place of sepulchre by them, ages after they had served as a place of retreat for wild beasts, especially the *Ursus spelæus*, the bones of which are always found under the superficial deposit which contains the traces of man. Cæsar, Florens tells us, ordered his lieutenant, Crassus, to shut up the crafty inhabitants of Aquitaine in the caverns in which they hid themselves, many thus perished. As to the supposed skulls of Caribs, or of African race, found in the caves of Mailet, in Belgium, they are found associated with other skulls, which by their configuration belong to the Circassian race, according to M. Desnoyer, who considers that the analogy suggested by the others is due to an artificial depression, or to an individual peculiarity.

Touching these bone-caves, M. Robert asks M. Boucher de Perthes in his turn how it happens that these primitive inhabitants of Gaul made no ornaments, or amulets, with the bones of the elephant, rhinoceros, &c., or that they have not endeavoured to make use of the tusks of the former for weapons :—is it not because these bones, of which they could not ignore the existence, were fossils in every sense of the word, in their time, that is to say entirely deprived of animal matter and reduced to the nature of stone, and consequently improper (one must, however, except the Silurian mammoth preserved in ice) for the use they wished to make of them. It is impossible to say what period of time was necessary to change this organic matter which constitutes the solidity and tenacity of the bony substance, since the well authenticated remains of early Celtic inhabitants, which we can only allow to have been buried six thousand years, contain it still. In the supposed diluvium of the borders of the Somme one easily understands that objects of this kind are never found, as in the caverns of Aquitaine, where have been discovered so many remains of Celts and the lower animals.

M. Robert concludes his paper with a quotation from M. Desnoyers, "The Gauls would not have failed to make trophies of the remains of elephants, hyenas, and other grand mammifers, if they had been contemporaneous with man."

On the Cretaceous Deposits of Central Bohemia. By M. Lipold.

The Quader or Cenomanian group prevails in the south and central regions of this district. while the Pläner or Turonian group, appearing in isolated hills as far as near Mezeritch, is more exclusively represented in the north-east region. The strata of both, having suffered no disturbance, lie perfectly horizontal, or with a scarcely perceivable angle of inclination. Organic remains are of rare occurrence in them, except in the case of the limestones with *Hippurites ellipticus,* appearing in the south-east, either as isolated coral-reefs or associated with sandstones of the Quader group.

On the Tertiary and Diluvial Deposits of Central and Eastern Moravia. By M. Wolf.

The tertiaries between Brünn and Olmütz, belonging to the marine deposits of the Vienna Basin, occupy a narrow zone running from Steinabrunn north-eastward between the ranges of the Austro-Moravian hills into Moravia, and filling up, towards Olmütz, several bays, cut into deposits of older date, as, for instance, in the Zevittawa Valley and around the Mährisch-Trüban. This northern bay near Brünn was a branch of the north-eastern arm of the sea extending, during the Miocene period, in a north-eastern direction, and connecting, after having passed over the anticlinal of Weisskirchen, the tertiary basins of Vienna and Gallicia. Fossiliferous localities are rather numerous, and among them Rausnitz and Ruditz are conspicuous for numbers and variety of organic remains. Of twenty-four species collected at the second of these places, fifteen also occur at Baden (S. of Vienna), and fourteen at Steinabrunn (N.N.E. of Vienna), so that, as far as evidence at present goes, the faunæ of these three localities may be considered as nearly, if not completely identical.

Ruditz and Rausnitz also, separated only by a distance of three Austrian (between fourteen and fifteen English) miles, possess in common only two species of Gasteropods. Ruditz is one of the highest fossiliferous localities in the Vienna basin, lying about 1400 feet above the level of the Adriatic. Leitha limestone and the sandstones connected with it, appear only as isolated but well-characterized hills, rising above the surrounding plain.

Four subdivisions may be distinguished within the diluvium of the region here in question:—1st, Erratic blocks and boulders; 2nd, Inferior loam (Löss); 3rd, Terraced detritus; and 4th, Upper or valley loam (Löss).

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—*April* 24, 1861.

1. "On the 'Symon Fault' in the Coalbrook Dale Coal-field." By Marcus W. T. Scott, Esq., F.G.S.

This communication was based on observations made during many years on a section through a part of the Shropshire Coal-field in nearly a straight line from north to south, commencing at the Greyhound Pit, near Oakengates Tunnel of the Shrewsbury and Birmingham Railway, and terminating at John Anstice and Co.'s Halesfield Pits near Madely. Particular reference was made to the explanation of the nature of the Great East or Symon Fault. The author commenced making his observations on the Malinslee and Stirchlee Royalties in 1843; and in 1845 he came to the conclusion that what the miners termed in this locality the "Symon Fault," that is the successive dying out of certain coal-seams, ironstones, &c., at various depths underground, was due to an old denudation which had produced an inclined surface at the expense of some of the beds before the upper measures were deposited. Having obtained, in course of time, correct sections of several pits situated in the N.—S. line above mentioned, the author, taking the "Little Flint" (the lowest workable coal) as a base-line, plotted the several shifted segments of the coal-field in a vertical plan, and thus restored the original outline of the denuded area (one side of a valley) as seen in a transverse section. Six sinkings in the N.—S. line having indicated the successive disappearance of five workable coal-beds in a distance of 2484 yards, a seventh pit, 2000 yards further south, was found to yield all the coals again, and the author thinks that between the sixth (the Grange) and the seventh (Halesfield) pit the coals re-occur successively on the opposite side of the old valley of denudation, and that they may here be sought for and worked advantageously. The line of the old valley of denudation apparently strikes the Great East fault, as laid down on the Geological Survey Map, at a considerable angle.

2. "On the Occurrence of *Cyrena fluminalis* associated with Marine Shells in Sand and Gravel above the Boulder-clay at Kelsey Hill near Hull." By Joseph Prestwich, Esq., F.R.S., Treas. G. S., &c.

The author's observations tended to show that the *Cyrena fluminalis*, instead of being limited, in its occurrence, to beds beneath the Boulder-clay (under which circumstance it is found in Norfolk), occurs in deposits of newer date; and that the argument, that the well-known beds at Grays, in Essex, are older than the Boulder-clay, depending much on the presence of this shell, would lose much of its force if this *Cyrena* were proved to belong also to the newer geological horizon. The question is now the more important, as this shell has been found by Mr. Prestwich in the beds that contain flint implements at Abbeville.

The author proceeded to show that some gravels and sands near Hull in Yorkshire, formerly described by Professor Phillips, contain abundance of the *Cyrena fluminalis*, associated with twenty-two species of marine shells, two of which have Arctic characters, the others being common littoral forms. These gravels and sands were proved, by well-sections and other exposures, especially by borings and trenches made by the author and Mr. T. J. Smith, F.G.S., of Hull, to overlie the Boulder-clay.

May 8, 1861.

1. "Description of two Bone-caves in the Mountain of Ker, at Massat, in the Department of the Arriège." By M. Alfred Fontan. Communicated by M. E. Lartet, For. Mem. G. S.

The valley of Massat, on the northern side of the Pyrenees, is of triangular shape, its northern angle being narrowed by the projecting limestone mountain of Ker. Among the fissures and grottos that traverse this mountain in every direction are two caves in particular; one is situated near the top, at about 100 metres above the valley; the other is near the base, at about 20 metres above the river. They both open towards the north. In the upper cave M. Fontan found a sandy loam with pebbles (the pebbles being of rocks different from that of the mountain), extending inwards for 100 metres, and containing a large quantity of bones of *Carnivora*, *Ruminantia*, and *Rodentia;* those of the great Cave-bear, a large *Hyæna*, and a large *Felis* being the most numerous. On the surface some fragments of pottery, an iron poignard, and two Roman coins were found, with a quantity of cinders and charcoal; and at a depth of more than three feet in the ossiferous loam another bed of cinders and charcoal was met with, and in this M. Fontan found a bone arrow-head and two human teeth; the latter were at a distance of five or six metres one from the other.

In the lower cavern a blackish earth, with large granitic and other pebbles, was found to contain bones of the Red-deer, Antelope, Aurochs, and Lynx; also worked flints and numerous utensils of bone (of deer chiefly), such as bodkins and arrows; the latter have grooves on their barbs, probably for poison. Some of the bones bear marks made of incisions by sharp instruments in flaying or cutting up the carcases. In each cavern a chasm crosses the gallery and terminates the deposits; in the upper cave at 100 metres, in the lower one at about seven metres from the entrance.

The author argues that, from the facts which he has noticed, these caverns must have been subjected simultaneously to the effects of a great transient diluvial cataclysm coming from the N.N.W. or West, in the opposite direction to the present course of the waters of that region; that man and all the other animals the remains of which are buried in these caves existed in the valley before this inundation; and that the greater part of the animals inhabited the caves, but that man was not contemporary with all of them.

2. "Notes on some further Discoveries of Flint Implements in the Drift; with a few suggestions for search elsewhere." By J. Prestwich, Esq., F.R.S., Treas. G.S.

Since the author's communication to the Royal Society last year on the discovery of Flint Implements in Pleistocene beds at Abbeville, Amiens, and Hoxne, similar implements have been found in some new localities in this country.

In Suffolk, between Icklingham and Mildenhall, Mr. Warren has met with some specimens in the gravel of Rampart Hill in the valley of the Lark. This gravel is of later date than the Boulder-clay of the neighbourhood. In

Kent, Mr. Leech, Mr. Evans, and the author found some specimens at the foot of the cliffs between Herne Bay and the Reculvers. The author believes them to have been derived from a freshwater deposit that caps the cliff, and which has been found by Mr. Evans and himself to yield similar specimens at Swale Cliff near Whitstable. In Bedfordshire, Mr. J. Wyatt, F.G.S., has found some specimens in the gravel at Biddenham, near Bedford; this gravel also is of freshwater origin, and is younger than the Boulder-clay. In Surrey, a specimen found in the gravel of Peasemarsh twenty-five years ago has been brought forward by its discoverer, Mr. Whitburn of Guildford. In Herts, Mr. Evans has found a specimen in the surface-drift on the Chalk Hills, near Abbots Langley. Lastly, the author recommended that diligent search be made in the gravel and brick-earth at Copford and Lexden near Colchester, at Grays and Ilford in Essex, at Erith, Brentford, Taplow, Hurley, Reading, Oxford, Cambridge, Chippenham, Bath, Blandford, Salisbury, Chichester, Selsea, Peasemarsh, Godalming, Croydon, Hertford, Stamford, Orton near Peterborough, &c.

3. "On the *Corbicula* (or *Cyrena*) *fluminalis* geologically considered." By J. Gwyn Jeffreys, F.R.S., F.G.S.

Mr. Jeffreys has identified the species of *Corbicula* found by Mr. Prestwich in a raised sea-beach at Kelsey Hill in Yorkshire with that of the Grays deposit, as well as with the recent species from the Euphrates and the Nile. He mentioned the great tendency to variation in freshwater shells, and the distribution of the same species throughout different and widely separated parts of the world; and he therefore considered that there was no difficulty in supposing that the *Corbicula* was contemporaneous in this country with Arctic shells found with it at Kelsey Hill. According to Mr. Jeffreys, specimens of Testacea from the north are larger than those of the same species from southern localities.

May 22, 1861.

1. "On the Geology of a part of Western Australia." By F. T. Gregory, Esq. Communicated by Sir R. I. Murchison, V.P.G.S. &c.

The author first described the granitic and gneissose tract of the elevated table-land ranging northwards from Cape Entrecasteaux and comprising the Darling Downs. The igneous rocks and quartz-dykes, the clays, sandstones and conglomerates capping the table-land; and the carboniferous, cretaceous (?), and pleistocene rocks were described, and some evidences of the recent elevation of the coast brought forward. The following fossils from Western Australia were exhibited: Carboniferous fossils and cannel-coal from the Irvin River; Fossils of secondary age (*Trigoniæ*, *Ammonites*, and fossil wood) from the Moresby Range; fossil wood from the Stirling Range and from the Upper Murchison River; Ventriculites in flint from Gingin; and Brown-coal from the Fitzgerald River.

2. "On the Zones of the Lower Lias and the *Avicula contorta* Zone." By Charles Moore, Esq., F.G.S.

Referring to a paper on this subject, by Dr. Wright, which appeared in the sixteenth volume of the Society's Journal, the author stated that details of the section at Beer-Crowcombe (near Ilminster) in Somersetshire are now more fully known than they were when the Rev. P. B. Brodie, after having been taken to see that section by the author, communicated to Dr. Wright the notes on it that are published in the paper above referred to. In the first place, Mr. C. Moore described the characters of the Liassic beds at Ilminster, and their relations to the *Avicula contorta* beds and the Keuper as seen in passing from Ilminster through Beer-Crowcombe to Curry-Rival and North Curry,—a distance of ten miles. He then treated of the subdivisions of the Lower Lias and the true position of the "White Lias;" and stated that, although Dr. Wright had proposed the following classification—5. *Ammonites Bucklandi* zone; 6. *A. Planorbis* zone (including the White Lias and the *Ostrea* beds); and 7. *Avicula contorta* zone, yet he preferred to group them thus—5. *A. Bucklandi* zone; 6. *A. Planorbis* zone; 7. Enaliosaurian zone; 8. White Lias; 9. *Avicula contorta* zone: 8 and 9 being equivalent to the "Kössener Schichten" or "Rhætic beds" of Gümbel and other Continental geologists.

The arguments in favour of his views the author based chiefly on observations made at Beer-Crowcombe, Stoke St. Mary, Pibsbury, Long Sutton, and other places in Somersetshire; and on a critical examination of the sections at Street, Saltford, &c. as given by Dr. Wright.

The communication concluded with descriptions of upwards of sixty species of fossils belonging to the Rhætic beds of England (including their thin representatives discovered by the author in the Vallis near Frome); twenty-eight of these species are new.

June 5, 1861.

1. "On the Occurrence of some large Granite Boulders, at a great depth, in West Rosewarne Mine, Gwinear, Cornwall." By H. C. Salmon, Esq., F.G.S.

The boulders of granite referred to were found in the 50-fathom level below the adit, the adit being 24 fathoms from the surface. One of the boulders was 4 feet 2 inches, and another 3 feet 10 inches in diameter; there were five other smaller boulders or pebbles also met with in the level. The boulders are in the killas close to the lode, and both the lode and the "country" near the lode are made up of brecciated killas. After quoting the details of somewhat similar phenomena formerly observed at Relistian and Herland Mines, the author treated of the probable origin of the boulders in question; and although lodes are regarded by some as having been formed from below upwards, yet in this case the author thinks that the boulders must have had a common origin with the lode, and have been introduced by a fissure from the surface.

2. "On an erect Sigillaria from the South Joggins, Nova Scotia." By Dr. J. W. Dawson, F.G.S.

This specimen, presenting the external markings of leaf-scars and ribs with more than usual clearness and with some instructive peculiarities, has afforded to the author the type of a new species, *Sigillaria Brownii*. Observations on the probable style of growth, on the structure, and on the classification of *Sigillariæ*, were also given in this paper, together with a *résumé* of the observations previously published regarding *Sigillaria* by Brongniart, Corda, and others.

3. "On a Carpolite from the Coal-formation of Cape Breton." By Dr. J. W. Dawson, F.G.S.

Numerous *Trigonocarpa* belonging to a new species (*Trigonocarpum Hookeri*) occur in a thin calcareous layer in the coal-measures near Port Hood, Cape Breton. The author thinks it highly probable that, though some *Trigonocarpa* may have belonged to Conifers, yet in this case they were the seeds of *Sigillaria*.

4. "On a Reconstructed Bed on the top of the Chalk." By W. Whitaker, Esq., B.A., F.G.S.

At some places near Reading (Maidenhatch Farm, about six miles to the W.; and Tilehurst, two miles to the S.W.), and also near Maidenhead, from 18 to twenty feet of broken chalk overlies the true chalk; and in places is overlain by the bottom-bed of the Reading Beds, and therefore must have been reconstructed before the deposition of the Tertiary strata. For the most part, however, in Berkshire the Woolwich and Reading beds rest on an undisturbed surface of the Chalk. In Wiltshire, also, the author has observed similarly constructed chalk, probably there also underlying Tertiary beds; and he suggests that possibly the local reconstruction of the Chalk may have been contemporaneous with the formation of the Thanet Sands further to the east.

5. "On some of the Higher Crustacea from the British Coal-measures." By J. W. Salter, Esq., F.G.S.

In this paper were described, (1) a new Macrurous Crustacean, under the name of *Anthrapalæmon Grossarti*, from the slaty band of the black band ironstone of the coal-measures, Goodhock Hill, Shotts, Lanarkshire. (2) The Macrurous Crustacean of which an imperfect specimen was figured in Mr. Prestwich's memoir on the Coalbrook Dale Coal-field (plate 41, fig. 9, *Apus dubius*): this is referred to a subgenus (*Palæocurubus*) of the genus *Anthrapalæmon;* and another specimen from Ridgeacre Colliery was referred to. (3) A specimen from the Carboniferous Limestone of Derbyshire. (4) A small Crustacean, from the Mountain-limestone of Fifeshire, figured and described by the author in the 'Transactions of the Royal Society of Edinburgh,' vol. xxii. p. 394, as *Uronectes socialis,* but now regarded by him as belonging to the Macrura.

Royal Institution.—*March* 22, 1861.

"On the Origin of the Parallel Roads of Lochaber (Glen Roy)." By Professor H. D. Rogers, F.R.S., F.G.S., &c.

The speaker prefaced his account of these curious features in the scenery of Lochaber, by stating that he was induced to recall attention to them from having, during four recent visits to the ground, discovered certain phenomena not hitherto noticed or theoretically considered by any of the able and distinguished observers who have preceded him. Though nearly all the more prominent peculiar characters of the scene have been very skilfully described and discussed by Dr. MacCulloch, Sir Thomas Dick Lauder, Charles Darwin, Esq., David Milne Home, Esq., Professor Agassiz, Sir George S. Mackenzie, Robert Chambers, Esq., and others, Professor Rogers has been led by a careful study of the structure of the so-called Parallel Roads, and a perusal of the views of those eminent geologists, to reject all the hypotheses thus far offered in explanation of the terraces as inadequate, and to recognize in the facts about to be developed, a key to a solution of the problem of their origin which he thinks may prove satisfactory.

The geographical area of the parallel roads may be defined as embraced between Loch Laggan and Loch Lochy, east of the Great Caledonian Valley. They are chiefly restricted indeed to Glen Spean, Glen Roy, and two or three immediately adjacent smaller glens. One belt of them ranges from near Spean Bridge up the Spean Valley, to beyond the head of Loch Laggan; another up Glen Roy to the water-sheds at its very head, and a third through Glen Gluoi to its head.

The "Roads" or Shelves themselves are of various heights above the sea, the lowest of the three conspicuous ones in Glen Roy having an elevation of about 850 feet, the middle one a height of about 1060 feet, and the highest a level of nearly 1140 feet. Other much fainter, still more elevated shelves are discernible in Glen Gluoi, but all hitherto seen lie below a horizon of 1500 feet above the ocean. These Parallel Roads, as they are called, are apparently level, and therefore parallel, but further instrumental measurements are necessary before the question of their absolute horizontality can be regarded as satisfactorily settled.

They constitute a most impressive feature in the scenery of the lonely, treeless glens containing them. Winding into all the recesses and round the shoulders of the mountains which they imprint, they present at first view a striking likeness to a succession of raised beaches deserted by their waters.

Seen in profile, as when looked at horizontally, they resemble so many artificial hill-side cuttings, the back of each terrace lying within the general profile of the mountain slope, while the front or outer edge is protuberant beyond it. Each is indeed a nearly level, wide, deep groove, in the easily eroded boulder drift, or diluvium, which to a greater or less thickness everywhere clothes the sides of these mountains. They vary greatly in their relative distinctness, being in some places vaguely discernible, while in other spots they indent the surface very plainly, just as they happen to be narrow and to coincide in slope with the hill, or to be broad and apparently level from front to back. Where most indistinct they are frequently not discernible at all when we stand upon them; though we may in a favourable light have detected their position and course from the opposite side of the glen, or, better still, from the bed of the valley. The conditions which influence this fluctuation in distinctness promise, if carefully observed, to dispel much of the obscurity which has hitherto invested the origin of the terraces. The modifying circumstances seem to be all referrable to one general condition, that of exposure to a current or inundation, supposed by the speaker to have rushed through these glens from their mouths to their heads, or upper ends. Thus it would appear: 1st, With scarcely an exception, that each terrace or shelf is most deeply imprinted in the hill-side, and is broadest where the surface thus grooved has its aspect *down the glen* or towards the Atlantic, and is faintest where the ground fronts towards the head of the valley on the German Ocean. 2nd, While conspicuous on the open sides and the westward sloping shoulders of the hills, the terraces *disappear altogether* in the recesses or deeper corries which scollop the flanks of the mountains. 3rd, Each shelf, or "road," grows usually more and more distinct as it approaches the head of its own special glen, until those of the two opposite sides meet in a round spoon-like point.

A fact obviously material to a true theory of the origin of the terraces is, that each of them coincides accurately in level with some water-shed or notch in the hills leading out from its glen into some other glen or valley adjoining, a coincidence suggestive of the notion that they were formed by the grooving agency of a flood pouring through the glens while it was embayed at the respective levels of these natural waste weirs. In confirmation of this view that they were transiently caused by erosive currents held successively at the heights of the barriers on whose levels the terraces terminate, we have as another interesting general feature, a remarkable ruggedness of the bed of each *external* glen just outside the water-shed or barrier closing the glen which contains the terrace. These rough and deep ravines, contrasting strikingly with the smooth spoon-like terminations of the terrace-lined glens which head against them, strengthen the suggestion already awakened by the marks of horizontal erosion in the terraces themselves, that the notches or passes which determined the grooving of the hill-sides on their one hand were externally the sites of so many stupendous cataracts.

The internal structure or disposition of the matter composing each terrace, affords a further and striking corroboration of this hypothesis of the passage of an erosive flood. It consists in an "oblique lamination," or slant bedding of the constituents of the shelves—viz., the layers of gravel, sand, and other sediment, such as geologists familiarly recognise as the result of a strong *current* pushing forward the fragmentary material which it is depositing, and which is held by them to indicate in the direction towards which the laminæ dip, the direction towards which the current has moved. Now, it is a most suggestive peculiarity in the oblique bedding of these terraces, that the "dip," or downward slant, is almost invariably *up* the glen, or towards its *head*, and *not down the glen*, or towards the Atlantic, as we must suppose it would have been, had the glen been a bay of the sea, and these materials but portions of ordinary sea-beaches. Indeed, this feature is of itself enough to suggest an origin due to a strong current sweeping inward from the Atlantic, and across the water-shed of the island to the opposite sea.

The speaker next proceeded to examine the hypotheses of his predecessors in this inquiry respecting the origin of Parallel Roads. They all assume the agency, in one form or another, of *standing* water, either the ocean in its ordinary state of repose, or lakes pent within the glens.

The notion that a quietly resting sea has fashioned these level shelves is refuted by the fact that they are not true marine beaches; they exhibit none of the distinctive features of genuine sea-shores, not a vestige of any marine organic remains, no rippled sands, no shingle, and no sea-cliffs. They display in like manner a total absence of the distinctive marks of lake sides; not one lacustrine organism, neither fresh-water plant, nor animal having ever been discovered imbedded in them. A further difficulty attends the lake-hypothesis in the necessity it imposes of discovering a feasible cause of blockage of the glens at different stations above their mouths, to pond the waters to the respective heights of the terraces. Though much ingenuity has been expended upon this part of the problem, no suggestions yet offered of barriers of gravel, accumulated by currents or glaciers from Ben Nevis, can be regarded as admissible, inasmuch as there are no traces of any such in any of those localities where alone we can assume them to have existed to produce the required embaying of the waters. In this entire absence of all remnants of the supposed natural dams across the glens, it is most unphilosophical to take for granted their total obliteration, where no cause has or can be assigned which can have so effaced them.

On the other hand, the hypothesis of successive "sea-margins," or sea-levels, is overthrown by the now well-established deduction from the professor's own recent measurements, that none of the several shelves, or "roads," of Glen Roy correspond in level with any of those seen in the adjacent valley Glen Gluoi, a marked discrepancy separating the two groups of terraces into two independently produced systems. It can be shown, moreover, that these discordances of interval between the shelves of the glens respectively, are such as cannot be accounted for on any supposition of "faults," or dislocations of the earth's crust, in the ground between the two glens. Equally incompatible are all the facts of the relative levels of the shelves, with the notion that they are possibly sea-beaches which may have undergone an *unequal* amount of elevation by an oblique secular rise of the land, such as is known to be very gradually taking place on some coasts at the present day. The individual terraces are too nearly level to admit of this explanation, since so wide a warping of the crust from horizontality within so limited a space as separates the two glens, would have left them conspicuously sloping. Besides, the two systems of shelves are wholly insulated from each other, and the notion of their origin as sea-beaches gradually elevated implies a continuity between them, together with certain agreements in their directions of derivation from levelness which we wholly fail to perceive.

In conclusion, the speaker proceeded to sketch the action to which he ascribes the formation of all these shelves or parallel roads. He supposes the several terraces to have been cut or grooved in the sides of the hills by a great inundation from the Atlantic, engendered by some wide earthquake disturbance of the ocean's bed, and forced against the western slope of Scotland. The features of the country indicate that, while a portion of such a vast sea-tide entering the Firth of Linnhe rushed straight across the island through the deep natural trench, Glen Mor, or the great Caledonian valley, a branch current was deflected from this, and turned by the Spean valley and its tributary glens, Glen Roy and Glen Gluoi, into the valley of the Spey, and so across to the German Ocean. In this transit, the deflected waters first embayed in these glens, and then filling and pouring through them, would, upon rising to the levels of the successive water-sheds, or low passes, which open a way to the eastern slope of the island, take on a swift current through each notch, and as long as the outpour nearly balanced the influx, this current, temporarily stationary in height, would carve or groove the soft "drift" of the hill-side. But the influx increasing, the stationary level and grooving power of the surface stream would cease, and would only recommence when the flood rising to the brim of another natural dam, a new temporary equilibrium would be established, a new horizontal superficial current set in motion, and a second shelf or terrace begin to be eroded at the higher level. So each of the parallel roads is conceived to have been produced in the successive stages of the rising of one vast steady incursion of the sea. The lapsing back of the waters, unaccompanied by any sharp localized surface-currents, through the passes, could imprint no such defined marks on the surface, nor accomplish more than a faint and partial obliteration of the terraces just previously excavated during their incursion. This procedure was elucidated by likening it to what takes place when we allow a steady but *gradually increasing* jet of water to flow into a tank, perforated laterally with several orifices at successive elevations, the outlets permitting a somewhat less rapid rate of discharge than is equivalent to the influx. If such a tank be smeared internally with soft clay, the inpour can be so regulated in respect to its acceleration, that the water, as it rises successively to the levels of the several orifices will take on a horizontal motion or current, through, first the lower hole, and then the second and so on, and, remaining approximately stationary for a brief while on the level of each, will groove the soft clay as it passes out, until it swells above the orifice to reach the next. Some such process as this at the notches which terminate the glens will, it is believed, account for the terraces and all the features which belong to them.

Glasgow Geological Society.—On Friday, May 24th, the Queen's birthday, a large party of the members of this important society, accompanied by a number of ladies, took advantage of the holiday by making a lengthened excursion to the far-famed chasm of the "Whangie," Finnich Glen, and the Spout of Ballagan, all on the south-western borders of Stirlingshire. The excursionists, numbering about sixty, left Glasgow at 10 a.m., by two of Menzies' omnibuses, each drawn by four fine horses. The road led by Canniesburn and New Kilpatrick, towards the localities to be explored. The weather proved favourable, and the scenery by the way was much admired, the verdure of the fields having been heightened by the refreshing showers of the previous day. Emerging from the low-lying districts of the Lanarkshire coal-field, the delighted party quickly passed into a rich undulating tract of country, interesting to the eye of the geologist, and leading his imagination back to the time when the whole surface before him lay at the bottom of a stormy and ice-laden sea, when numerous currents, in their irresistible progress, scooped out the valleys, and the unequal denudation of the harder and softer strata contributed to impart to terra firma its present configuration. Such was one of the functions of the "drift-period." Passing the terraced fronts of the eastern termination of one of the ridges of the Kilpatrick range, a quarry at the roadside exposed the columnar structure of the trap-rock, not unusual in other parts of the district, as at the Pillar Craig above the village of Strathblane, and in the isolated hill of Dunglass, opposite the Spout of Ballagan. In this instance the columns are arranged at various angles to the horizon. The finely-wooded heights bounding the Strathblane Valley on the south now came into view, while on the north were observed the conical height of Dungoyne, and the long, unbroken front of the Campsie fells, rising, terrace upon terrace, stretching from the Earl's seat on the west towards Kilsyth on the east, and forming one of the principal features of this part of the country. The numerous glens with which the flanks of these hills are scarred exhibit much picturesque beauty, and afford not a few interesting sections of the stratified rocks and overlying trap, while, in their deep recesses, nestle many fine specimens of botanical rarities.

On rounding the wooded heights of Carbeth-Guthrie, the road pursues a westerly direction, when we get a glimpse of the distant Grampians through the valley of the Blane, cheering us with the anticipation that by the time we reach the brow of the hill overlooking the Whangie, we shall have a magnificent view of that tumultuous sea of mountains, stretching from the Argyllshire coast on the south-west through Perthshire towards the distant north-east. Having arrived at the gamekeeper's lodge, the party put themselves under his guidance, and were conducted over the swelling heights of Auchenedén by the shortest route to the Whangie, permission having been kindly granted by the proprietor, John Wilson, Esq., of Auchenedén, to visit the singular chasm. The excursionists at length reached the westeen brow of the hill, and were amply rewarded for their toil by the magnificent prospect spread out before them. In the foreground the fertile valley of Strathendrick is seen extending from Lochlomond on the west towards Fintry valley and Stirling on the east, while in the rising ground towards Callander and Aberfoyle a fine view is obtained of the Menteith district, with the lake of the "Port," and its three verdant islets reposing on its placid bosom in calm sequestered beauty. The most prominent expanse of water seen from this point is Lochlomond; and there is perhaps no other locality from which a more interesting and extensive view of the queen of Scottish lakes may be obtained. No intervening heights obstruct the eye, and lighted up as it was by the bright rays of the noon-day sun, its numerous islets, and objects on its surface even more minute, although at a considerable distance, were distinctly visible to the unassisted sight; and while the party was looking down upon them, the steamer, with its long line of smoke, was perceived threading its devious course with its living freight of pleasure-seekers. Among the lofty mountains that form the background of this magnificent landscape, Benlomond stands out in bold relief, bearing on its summit lingering patches of the snows of winter. The rich tract of lowland in the foreground, with its verdant pastures and cultivated fields, dotted with comfortable farmsteads and snug mansions, formed an agreeable contrast to the rugged grandeur of the distant hills, melting away in the far north into those aerial tints that artists love.

The winding recesses of the Whangie were explored, many of the party having traversed the chasm several times, remarking the exactness with which the opposite sides correspond, and offering opinions as to the cause by which this remarkable fissure has been produced. The greater number then proceeded to refresh themselves at a cool and glassy spring that issues from the foot of a verdant slope below the Whangie, while a second party took exact measurements of its dimensions and bearings. Having done so, they found that the results corresponded very closely with those given in the "Statistical Account" of the parish of Killearn. The Whangie may be described as a considerable chasm or rift running parallel with the face of a cliff, in a slightly tortuous line, from north to south, through the western shoulder of one of the ridges of the Kilpatrick range, which consists of a splintery greenstone overlying old red sandstone, here forming the base of the hill, and cropping out a little farther to the north. The force which has produced this terrible fissure has rent from the main body of the hill a huge wall of rock, varying from ten to twenty feet in thickness at the base, and gradually narrowing towards the top. The width of the chasm, at the northern extremity, is about ten feet and a half, and it gradually narrows to about four feet at the other, widening out a little at the top. The length is about 350 feet, but may have been originally about ten feet more, as the extremities of the wall appear to be considerably disintegrated. Its depth was found at one point to be forty feet, but it contains a large quantity of *débris* from the upper part of the hill. The opposite walls are on the same level, and many of the angles are as sharp as if the rent had been the work of yesterday. This is, no doubt, owing to their sheltered position. On looking outside the main wall of the chasm, which is broken through in one or two places, a line of huge blocks of rock is seen extended along the face of the cliff, and tumbled together in rugged confusion. Various conjectures have been advanced as to the cause of the fissure, some supposing it the result of a convulsive movement of the earth's crust, while others, who have never visited the Whangie, have suggested the idea that it may originally have been a crevice containing, in the manner of a gash vein, softer rock matter which has been carried off by aqueous or atmospheric agency. The Whangie might, no doubt, have been the result of local convulsion, but there is no evidence in the appearance of its opposite walls of a violent upthrow or downthrow of either, or of any such matter ever having been present. It seems from the first to have existed as an open fissure, and its position forbids the idea that it ever formed the channel of a flow of water. The most tenable hypothesis is that the subsidence of the sandstone, which appears, where exposed, to be of a thin-bedded and friable nature, may have left a long ledge of the overlying bed of trap without support, causing it to part gradually from the main body of the rock by its own weight, the accumulation of water in the fissure probably contributing to the result; but while it is evident that a large mass of the rock has been rent from the main body of the hill, it does not appear, from the corresponding sides, to have sunk to a much lower level, and this can be well seen near the middle, where the fractured sides are most perfect. A little farther to the north, on the same side of the hill, several other fissures of inferior dimensions are said to have existed; but they have been filled up to prevent sheep from falling into them. One, however, is still partially open, and may extend about 100 feet along the hill-side, with a width of about four feet at its northern end. Like the large rent, it lies north and south. It is difficult to account for these fissures, even by attributing them to subsidence, for the hill is in no place very precipitous, and the party could see no evidence of the rock having been undermined either by aqueous or atmospheric agency. Leaving the grey, weather-beaten rocks of the Whangie and their speculations as to its origin behind, the excursionists wended their way to a point where the omnibuses were waiting, and proceeded to Finnich Glen. To those who have never seen this romantic glen, it would be difficult in words to convey an adequate idea of the grandeur of its scenery. It may be doubted if there be another glen in the West of Scotland that can at all compare with it. The mountain stream, in its descent to the valley of the Blane, has, for a long succession of ages, been gradually cutting its way, till it has attained a depth of about 100 feet. The walls of the glen are nearly vertical, and it would have been next to impossible to descend safely to the bed of the stream, had not the proprietor, Mr. Blackburn, of Killearn, considerately made a stair of about ninety steps through a rift in the rock for the accommodation of the visitors who frequent this romantic glen. The walls are in many places not more than from ten to twenty feet apart, and clothed with beautiful ferns and other cryptogamic plants of greenest hue, which harmonise delightfully with the bright red colour of the sandstone. The stream has scooped out a series of deep round cavities in the softer layers of rock all along its course, adding to the fairy-like features of this charming ravine. At one point, where diverging currents had formerly existed when the bed of the stream stood at a higher level, a large mass of the sandstone has been separated from the walls of the glen, and now stands in the middle of the stream. It has been named the "Devil's Pulpit," and is the principal rendezvous for pic-nic parties. Our geologists, however, duly exorcised this Satanic region, and having spent a pleasant hour in this secluded spot, proceeded by their omnibuses along the valley of Strathblane, and by the wooded hill of Dungoich, and the towering heights of Dunfoyne and Dungoyne.

Passing on the right the old ruin of Duntreath Castle, with its ivy-clad walls, and the "big oak" of Blairwhush, they arrived at Strathblane. Here the teams were unharnessed for an hour, and most of the excursionists proceeded on foot to visit the Spout of Ballagan, a short distance to the east, on the north side of the valley. The magnificent section of thin-bedded strata seen at the Spout proved extremely interesting. After procuring several varieties of gypsum and other specimens, the party returned to Strathblane, and proceeded to Glasgow by Milngavie, highly delighted with the day's proceedings. Indeed, this has been the most successful of all the excursions the society has yet had, whether we consider the number who joined in it, or the interest manifested in the localities visited.

It being the first to which ladies have been admitted, their cheerful presence added much to the general enjoyment, while they were not behind the gentlemen in locomotive power. It is to be hoped that frequent opportunities may be afforded them of joining in future excursions of the society.

THE WOOLHOPE AND MALVERN NATURALISTS' FIELD CLUBS.—The members of the Woolhope and Malvern Naturalists' Field Clubs met at Ludlow on May 23rd and 24th, for two field-days. The first excursion was to examine the Caradoc beds up the Onny Valley, and at Marsh Brook and Acton Scott. The Malvern members arrived on Wednesday night, proceeded by train next morning to Marsh Brook, and from thence walked to a quarry near Acton Scott, in the middle Caradoc formation, which is rich in fossil remains. From thence the members retraced their steps to Marsh Brook, and examined the sections along the Horderley Road. Those nearest the railway station are Caradoc, and a little further on are the beds of the Longmynd or Bottom Rocks, all the beds of which were considered to be unfossiliferous until Mr. Salter, about two years ago, discovered worm-tracks, and a portion of a Crustacean, in the grey beds immediately overlying the olive shales. A little further along the road is a large quarry of Bala limestone, the beds of which are tilted up nearly vertical, and on the lower side of the quarry the lowest beds of Caradoc formation lie conformably to it, containing several scarce and new organisms, such as *Trinucleus concentricus*, a new *Asaphus*, a new *Fenestella*, and several other remains; from the Bala limestone were procured several specimens of a new *Lingula*. From thence, crossing the River Onny by the stepping-stones, and proceeding by the side of the river, they examined the loose stones that are thrown down from several quarries of the Horderley flags or Middle Caradoc, amongst which the beautiful oak-fern (*Polypodium dryopteris*) grows most luxuriantly. About a mile further down the stream (though up the beds) the celebrated Onny section was reached, showing the Purple Shale or Lower Wenlock, the Pentamerus limestone, and the uppermost beds of the Caradoc, all in one continuous section. From the Caradoc were procured some fine specimens of *Trinucleus concentricus*, and from the Purple Shale *Orthis biloba*, *Encrinurus punctatus*, *Leptæna lævigata*, *Atrypa reticularis*, and *Petraia bina*. The Pentamerus limestone is here a very thin band, containing only *Pentamerus undatus ;* thence a walk of about a mile and a half to Craven Arms and back to Ludlow per train, concluded the first day's excursion.

The second day's trip was first to Mocktree. After examining the fine sections of Aymestry limestone, and Lower Ludlow rock, the party proceeded to Leintwardine, where they separated for a short time, Mr. Symonds and Mr. Lightbody going on further to Pedwardine, to examine the small upheaval of Lower Llandeilo flags, containing *Dictyonema sociale* in abundance, and a small species of *Lingulella*. The remainder of the party went on to Church Hill. The Church Hill quarries have been more productive of new organisms than any other section in this locality; twelve new species of Star-fish, several Encrinites, a few Ceratiocarides, and two or three specimens of *Limuloides*, an organism allied to the king-crabs of our existing seas, have been found there. It was in these beds of the Lower Ludlow formation that the oldest known *Pteraspis* was found. After Mr. Lightbody joined again the party, they continued on towards Ludlow, through the beautiful grounds belonging to Downton Castle, in which are some fine sections of Upper Ludlow rock. At the lower end of the Walks near Downton Castle Bridge, the Upper Ludlow Bone Bed is well exposed, and immediately overlying it is the Trochus bed, from which several small, but perfect, fish-heads have been obtained. A short walk from here to the Forge Bridge, and back to Ludlow by carriage, concluded the second day's excursion, through a most interesting locality both to the geologist and the botanist.

WORCESTERSHIRE NATURALISTS' CLUB.—The first meeting of this Club of practical observers was held May 15, at Malvern, when a large number of members responded to the hospitable invitation of Dr. Grindrod to breakfast with him at Townsend House. The officers of the club for the ensuing year are as follows:—The Rev. David Melville, rector of Great Witley, President; Rev. A. H. Winnington Ingram, F.G.S., and Edwin Lees, Esq., F.L.S., Vice-Presidents; and William Matthews, Esq., A.M., F.G.S., Hon. Secretary. Dr. Grindrod exhibited his unique collection of Silurian fossils, which had been arranged and classified according to the rocks in which they had been found purposely for the occasion. He indicated his intention to display his extensive collection in a building about to be erected for the purpose, which at certain times would be freely open to the public. The party proceeded up the hills to the pass of the Wych, descending the western declivity to the Great Winnings quarry. In the way down, an ancient coral-reef in the Wenlock deposits attracted much attention, and both here and at the Winnings numerous specimens of fossil corals and testacea were collected, and some good trilobites. The interest of the day was chiefly for the geologists, a party of whom stayed behind at the Winnings, being loaded too much for further progress. The botanists then made a traverse to Brockhill Wood, where, breaking through the briars, they found themselves in the romantic Purlieu Lane, a place of double interest, botanical and geological. Dr. Grindrod called attention to the "bone-bed" at the end of the lane, and the succession of strata from the Ludlow Rocks to the Old Red. The next advance was to the deserted mansion of the Cliffes, where ruin and decay suggested that the estate was or had been "in Chancery." The party next made a traverse to Mathon Church.

After the dinner at West Malvern, Dr. Grindrod then made some observations on geological matters, ending with the advantages to be derived from constant devotion to any pursuit, and proposed to enrol in their number a clever working man, of Cradley, Jacob Gill, who had been of great service in collecting and securing valuable fossils, which was done.

NOTES AND QUERIES.

The Computation of the Mosaic Chronology.—Sir,—Will you inform me in your next number on what data the computation of the Mosaic chronology is made to give a period of some 5,000 or 6,000 years since? I think we ought in the present state of relationship between geology and the bible to look carefully at both sides of the question in every aspect.—Yours truly, Edw. Allen, Bridport.

The President of the Geological Society, Mr. Leonard Horner, in the last annual address, treated at some length on this subject. We give his remarks without comment of our own.

"Modern discoveries in ethnology and philology afford cumulating proofs of the very remote antiquity of the human race. The Rev Dr. Williams, in his review of Bunsen's 'Biblical Researches,' observes:—'There is no point in which archæologists of all shades were so nearly unanimous as in the belief that our Biblical chronology was too narrow in its limits; and the enlargement of our views, deduced from Egyptian records, is extended by our author's reasonings on the development of commerce and government, and still more of languages, and physical features of race. How many years are needed to develope modern French out of Latin, and Latin itself out of its original crude forms! How unlike is English to Welsh, and Greek to Sanscrit, yet all indubitably of one family of languages! What years were required to create the existing divergence of members of this family! How many more for other families, separated by a wide gulf from this, yet retaining traces of a primeval aboriginal affinity, to have developed themselves, either in priority or collaterally! The same consonantal roots, appearing either as verbs inflected with great variety of grammatical form, or as nouns with case-endings in some languages and with none in others, plead as convincingly as the succession of strata in geology for enormous lapses of time.'

"There undoubtedly exists a widespread belief that the first existence of man belongs to a period not very remote from history or tradition. Every discovery which threw a doubt on the correctness of that belief was, until very recently, regarded, even by well-instructed geologists, as an imperfect observation, in which concomitant circumstances have been overlooked, which would have shown that the inference of a great antiquity was erroneous; nor have those who were led to make such inferences been always exempt from the charge of irreverently maintaining opinions at variance with Sacred Writ. To what cause can we ascribe this incredulity? How does it arise that, while the statements of geologists that other organic bodies existed millions of years ago are tacitly accepted, their conclusions as to man having existed many thousands of years ago should be received with hesitation by some geologists, and be altogether repudiated by no inconsiderable number among other educated classes of society? It is true that negative proof is brought forward that human bones have never been found associated with those of extinct animals; but granting this to be correct, which recent discoveries show that it is not (and the rarity of their occurrence is capable of being accounted for on many reasonable grounds), still against such merely negative evidence we have undeniable proofs, in numerous places, of the existence of such an association with man's works, and even many instances of his having applied the bones of such animals to his wants. My own conviction is, that this wide-spread belief of the recent existence of man is to be ascribed, so far at least as this country is concerned, to the impression made by the lesson taught in early youth, the soundness of which is not questioned in after life, by that marginal note in our Bibles over against the first verse of the first chapter of the Book of Genesis, that 'In the beginning God created the heaven and the earth' [four thousand and four years before the birth of Christ]. It is more than probable that of the many millions of persons who read the English Bible, a very large proportion look with the same reverence upon that marginal note as they do upon the verse with which it is connected.

"It will be useful to look into the history of this date of four thousand and four years, given with so much precision for the creation, not of this our earth only, but of the universe, and to inquire into the authority by which an addition of so much import is made to the sacred text.

"The author of the chronology given in the margin of our Bibles was Usher, Archbishop of Armagh. I make no allusion to any part of the learned prelate's system, except the date he assigns for the creation of the world: that date comes properly within the province of the geologist; for, as the almost religious belief in its accuracy is an obstacle to the acceptance of the conclusions to which he is led by a careful study of the facts which the structure of the earth exhibits, he is fairly entitled to deal with it.

"In the eighth volume of the Archbishop's works, there is a treatise with the following title:—'Annales Veteris Testamenti, a prima mundi origine deducti,' and in p. 13 of that treatise we find the following sentence:—'In principio creavit Deus cœlum et terram, quod temporis principium, juxta nostram chronologiam, incidit in noctis illius initium, quæ vigesimum tertium diem Octobris præcessit, in anno periodi Julianæ 710.' Then follows:—'Primo igitur sæculi die, Octobris vigesima tertia, feria prima, cum supremo cœlo creavit Deus angelos: deinde summo operis fastigio primum perfecto, ad ima mundanæ hujus fabricæ fundamenta progressus mirandus artifex, infimum hunc globum ex abysso et terra conflatum constituit.'

"In the eleventh volume of the same edition of the prelate's works there is a treatise with the title 'Chronologia Sacra,' in the second chapter of which the Archbishop thus settles the number of years, before the birth of Christ, for the creation of the world:—"Ita a vespera primum mundi diem aperiente, usque ad mediam noctem initium præbentem, 25, quidem diei Decembris, quo Christum natum supponimus annos Julianos 3999 menses τριακονθημερους 2. dies 4. et horas 6. Kalendis vero Januariis anni periodi Julianæ 4714. (a quibus vulgaris æræ christianæ exordium deducimus) annos 4003. menses 2. dies 11. et horas 6. decurrisse colligimus.' This, therefore, is the authority upon which the confident belief is founded, that man could not possibly have existed upon the earth for a longer period than considerably less than four thousand years B. C.

"But this determination of the Archbishop is only one of many dates which chronologists, in their vain calculations, have presumed to assign to this the most stupendous of all events, to attempt to form a faint idea of which, in anything relating to it, will ever be gross presumption and folly. In the well-known work, 'L'art de vérifier les Dates,' the following passage occurs:—'Les chronologistes sont loin d'être d'accord sur le nombre des années du monde. Desvignoles (Chronologie de l'Histoire Sainte, préface) assure qu'il a recueillé plus de 200 calculs différents, dont le plus court ne compte que 3483 ans depuis la création jusqu'à l'ère vulgaire, et le plus long en suppose 6984.' There then follows a 'Table des années écoulées depuis Adam jusqu'à la naissance de Jésus Christ, selon le calcul des principaux chronologistes,' numbering 108, beginning with

'Alphonse X, roi de Castille, mort le 24 Avril, 1284, dans les Tables de Jean Muller, appelé aussi Regiomontanus 6984,'

and ending with

'Louis Lippoman, savant Vénitien, mort en 1554 . ... 3616.'

"The Rev. Dr. Hales, in his 'New Analysis of Chronology,' gives a similar list of 'Epochs of the Creation,' and adds:—'Here are upwards of one hundred and twenty different opinions, and the list might be swelled to three hundred. This specimen, however, is abundantly sufficient to show the disgraceful discordance of chronologers even in this prime era.'

"I have endeavoured, by inquiries at Oxford, Cambridge, Edinburgh, and at the Queen's printers in London, to ascertain by what specific authority, royal or ecclesiastical, the date of 4004 was added to the first verse in Genesis in the authorized vertion, and I have not been able to discover that any record exists of such an authority. In Lewis's 'Complete History of the Translations of the Holy Bible into English,' it is stated, in p. 319, that, to an edition in folio of the Bible, published in 1701, under the direction of Archbishop Tenison, Dr. Lloyd, Bishop of Worcester, added chronological dates at the head of the several columns, and on the margin of the title of Genesis the following:—'Year before the common year of Christ, 4004.' This edition is to be seen in the British Museum: it was printed by Charles Bill and the executrix of Thomas Newcomb, deceased, printers to the King's Most Excellent Majesty.

"The copy of the Bible in the Bodleian Library, Oxford, in which that date first appears over against the first verse of Genesis, bears the date of 1727; but there is no doubt that for more than a century and a half that unauthorized marginal note has been added, up to the present time.

"I have thus laid before you the origin of this settled point in Sacred History as taught at this day in our schools, and, from its juxta-position to the text of the Bible, held in veneration by millions, there is every reason to believe, as an undoubted truth. The study of geology has become so general that those who are instructed in its mere elements cannot fail to see the discrepancy between this date and the truths which geology reveals. The youth is told in the morning at school, probably by his own minister of religion, as I myself have witnessed, that not more than about six thousand years have elapsed since the creation of the world. In the evening he may attend a lecture on geology, very possibly by one of the ninety-three clergymen who are Fellows of this Society, and hear that, in a work just issued from the press (a Lecture by a Professor in the University of Oxford, delivered before the Vice-Chancellor of the University of Cambridge), it is stated that 'the probable length of time required for the production of the strata of coal, sandstone, shale, and ironstone in South Wales is half a million of years.' It is thus easy to see what a confusion must be created in the youth's mind, and that he will involuntarily ask himself, 'Which of the two statements am I to believe?' There can be very little doubt what his decision would be; for he found the lecturer resting his statement on unmistakeable records preserved in the great book of Nature, the genuine incorruptible register of God's works; whereas his school instructor had adduced no evidence from the sacred text for his averment. To remove any inaccuracy in notes accompanying the authorized version of our Bible is surely an imperative duty. The retention of the marginal note in question is by no means a matter of indifference: it is untrue, and therefore it is mischievous. If in future editions this erroneous date be removed, the omission of any other will best express that entire ignorance of 'The Beginning' which no human power will ever be able to dispel.

"I cannot conclude his subject better than by quoting the eloquent words of one of the most able and accomplished of our Associates, the Rev. Adam

Sedgwick, who, in the Appendix to his Discourse on the Studies of the University of Cambridge, thus expresses himself:—

"Between the first creation of the earth and that day in which it pleased God to place man upon it, who shall dare to define the interval? On this question Scripture is silent; but that silence destroys not the meaning of those physical monuments of his power that God has put before our eyes, giving us, at the same time, faculties whereby we may interpret them and comprehend their meaning. In the present condition of our knowledge, a statement like this is surely enough to satisfy the reasonable scruples of a religious man. But let us for a moment suppose that there are some religious difficulties in the conclusions of geology. How, then, are we to solve them? Not by making a world after a pattern of our own, not by shifting and shuffling the solid strata of the earth, and then dealing them out in such a way as to play the game of an ignorant hypothesis; not by shutting our eyes to facts, or denying the evidence of our senses, but by patient investigation, carried on in the sincere love of truth, and by learning to reject every consequence not warranted by direct physical evidence. Pursued in this spirit, geology can neither lead to any false conclusions, nor offend against any religious truth."

EVIDENCES OF DELUGE—GEOLOGY OF STONEHAVEN.—DEAR SIR,—May I trouble you with the two following queries?—

1. What evidence have we, geological or otherwise, apart from the history of the Bible, of the existence of the Deluge? The traditions of all nations, whether in the new or old world, would seem to point to it; but are they confirmed by direct evidence from the surface of the globe? If so, are we to suppose its action to have been local or general over the whole world, and what date can we assign to it? In no book can I find any clear answer to these questions.

2. Can you inform me whether there is any special interest in the geology of the country aroung Stonehaven, in Kincardineshire, and whether I could find any published account of it? Hoping you will excuse the trouble, believe me respectfully yours, S. M.

1. As the Biblical Deluge is supposed to have taken place in the East, it has been looked for in the valley of the Euphrates, and other great valleys, and such evidence with regard to the Euphrates valley as seems to bear on the subject, has been brought forward, if our memory serves us rightly, in Mr. William Ainsworth's "Reseaches in Assyria, Babylonia, and Chaldea," published in 1838.

In Mr. Vernon Harcourt's work on the Deluge a great deal of information is brought together on the subject of the Mosaic Deluge.

Geological evidence generally tends to disprove the Universality of the Deluge. Thus we have cones of volcanic ashes of early tertiary date still existing in central France entirely undisturbed, and modified only by atmospheric agencies.

2. Stonehaven stands on the northernmost extension of the Old Red of Forfar and Kincardineshire. The general stratigraphical features of the Old Red of this district, and a notice of the chief localities of fossils, have lately been given by the Rev. Hugh Mitchell, of Craig, in the Journal of the Geological Society (No. 66, p. 45, 1861). Some papers also on this subject have appeared in the "GEOLOGIST," namely, "On the Flagstones of Forfarshire," by Mr. Mitchell (vol. ii., p. 149, 1859), and "Notice of New Fossils from the Lower Old Red Sandstone of Scotland" (vol. iii., p. 273), by the same author; and "On the Old Red Sandstone and its Fossil Fish in Forfarshire, by Mr. J. Powrie (vol. iii., p. 336).

Balruddery, Tealing, Glammis, Carmylie, Leysmill, Carsegowrie, Brechen and Cauterland, are noted localities in Kincardine and Forfar for fossil fishes.

The coast from Stonehaven to Aberdeen affords a most interesting exposure of the structure of the Grampians. The Old Red Sandstone of Stonehaven is succeeded by the clay-slate of Carron Point and that in turn by mica-slate and gneiss, all of them frequently traversed by dykes of trap, porphyry, quartz, and granite. This subject is noticed in Nicol's "Guide to the Geology of Scotland," p. 180, &c., and in the Geological Society's Journal, vol. xi., p. 544.

Stereognathus Ooliticus from Stonesfield Slate.—Dear Sir,—I think that most of your readers will be glad to hear of the discovery of a second specimen of the hitherto unique jaw of the Stereognathus Ooliticus. Such a specimen I lately had brought to me by a young friend among other fossils for naming. On obtaining it from him, I showed it to my friend Professor Huxley, who very kindly worked the specimen out from the enclosing matrix. At first he believed it to be a new species altogether; but he tells me now, from further examination and comparison with the only other known specimen that he considers this also to be the Stereognathus Ooliticus. It should be remarked that my specimen has one more tooth than the original fossil, although the crowns of the little molars are not in quite so perfect a state of preservation. There is about the same amount of the jaw-bone preserved, which is clearly exposed, and in which the double fangs of the teeth (so characteristic of the mammalian class) may be seen embedded. The locality from which my specimen comes is rather uncertain; but shells and other fossils which were associated with it, and the appearance of the matrix itself prove it to be from the Stonesfield Slate.—I remain, sir, yours &c., E. Ray, Lanbeater.

Geology of Arabia.—Sir,—Could you kindly inform me, through the medium of your invaluable "Notes and Queries," what the principal geological features of Arabia consist in; or refer me to any book, paper, or pamphlet where I could find anything on the geology of that country? Also whether the deserts in the interior are of tertiary formation or not? If you could answer me these questions you would much oblige me.—Yours, &c., M. R. A., Newport Pagnall.

In the Journal of the Royal Geographical Society, vol. iv., p. 192, 1834, is a paper on the Southern Coast of Arabia and the shores of the Red Sea, in which geological observations are plentiful.

The south-east coast of Arabia has been treated of geologically (by Dr. H. J. Carter), in the Journal of the Bombay Branch of the Asiatic Society, for January, 1852.

With respect to geological maps of Arabia, we may mention the "Geognostische Karte des Petraischen Arabien (by J. Russegger, 1847, Schweizhart, Stuttgart).

The chief geological features in Arabia appear to consist of—1, granitic and metamorphic rocks (especially near the coast-line and in the Sinai district); 2, sandstone of undetermined age; 3, cretaceous rocks of considerable extent; 4, nummulitic and other tertiary strata in abundance; 5, post-pliocene sands, some of them rich in shells and foraminifera: some at least of the desert-sands belong to the last.

Geology of Yorkshire.—Dear Sir,—It is a regular custom for a few of us in this district, during the summer season, when we are favoured with a week's recreation, to visit some district in search of its geological treasures. We are this year anxious to visit the east-coast of Yorkshire, but more particularly Whitby and Scarborough; none of us, however, are acquainted with the formation of that district, and from the books which we have we can obtain very little information.

If you or some of your learned correspondents could, through the medium of your most valuable publication (which is taken by several, and read by every member of our society), give us some information as to the rocks of the coast I have mentioned, and a short account of the fossils which they contain, it would, to our young society, be a very great favour and a very great boon; and if you could recommend to us some cheap geological guide to that district, every one of us would be greatly obliged to you.—Yours truly, A Young Geologist, Huddersfield.

The coast of Yorkshire is full of geological interest; and, indeed, supplies typical sections of the oolites, and types of the oolitic fossils, which, though they bear a close relationship to those of the south-west of England, have their special characteristics. Prof. Phillips's work on Yorkshire (Illustrations of the Geology of Yorkshire, 2 vols., 4to) is the text-book for geologists visiting that coast. It contains a map, sections, and several plates of fossils. It was first published in 1829; and there was a new edition two or three years since. A larger and far better geological map of Yorkshire was published by Prof. Phillips in 1853, and can be got of Monkhouse, York; this must be the tourist's pocket-companion. Another work by the same author gives much information of the same country, namely, "The Rivers, Mountains, and Sea-coast of Yorkshire," 1853; it is well illustrated.

In 1822, Messrs. Young and Bird published "A Geological Survey of the Yorkshire Coast" (4to, Whitby), and this is still referred to for the sake of the figures and fossils in it, and other information.

In the Journal of the Geological Society of London (vol. xv., p. 4, plates 1, 2, 3), Mr. Leckenby gave an account and figures of the fossils of the Kelloway Rock of Yorkshire; and in the 15th vol. of the same Journal (p. 1, &c.), Dr. T. Wright compared the oolites of Gloucestershire with those of Yorkshire, and gave several sections, lists of fossils, and much information, with references to other writers on the same subject.

The east coast of Yorkshire consists chiefly of oolitic and cretaceous strata, with a large quantity of boulder-clay on its southern portion, just north of the Humber. On account of the richness of its fossils and the good development of its beds, the oolitic strata of Yorkshire have been regarded as type sections for many years.

The northern portion of the Yorkshire coast consists, for a few miles south of the Tees, of New Red Sandstone. This is soon covered up by the Lias, rich with iron-ore and full of fossils. The Great or Lower Oolite covers the Lias, and, together with it, is to be seen in the coast-sections along by Whitby to Robin Hood's Bay. The Oolite continues south of this along by Scarborough, showing its different stages; and the Middle Oolite then comes on, and in its turn is, at Filey Bay, covered up by the Kimmeridge Clay (of the Upper Oolite). The Speeton Clay, the Red Chalk, and the White Chalk, can then be seen in succession; and for an account of these we refer our correspondent to the "Geologist," (vol. vii., p. 262, &c.), where the Rev. Mr. Wiltshire has given a detailed account, more especially of the Red Chalk and the Speeton Clay of Yorkshire, Lincolnshire, and Norfolk. The Tertiary Crag of Bridlington, and the Boulder-clay of Holderness, are other objects of interest to the geologist, but are not so easily studied, perhaps, by the tourist as are the Oolitic and Liassic strata of Whitby, Scarborough, and their respective neighbourhoods.

New Trilobites.—Sir,—In the last month's number of the "Geologist," Mr. Salter accuses me of publishing several of his MS. names of new species of trilobites, which had not been described. I was not aware that they were undescribed, and that the names were not published, or most certainly I should not have drawn attention to them in the manner I did, and for which I offer him apology.

Mr. Salter speaks, in the same communication, of the "blundering" use of MS. names by me, all of which he says are wrong, but not having seen the specimens referred to how is it possible that he can know whether they are wrong or not.

The above specimens, together with many other species, I received from a gentleman residing in the immediate locality, who is a very enthusiastic collector of the Lower Silurian fossils, and who I believe was the discoverer of most of the species found in that part, many of which I am aware have been described by Mr Salter.

Mr. Salter's styling the communications from me in your "Notes and Queries" advertisements, is another mistake; but others know as well as myself how positively you close the pages of your journal against any transactions of a mercantile character.—I am, Sir, yours, &c., JAMES R. GREGORY.

NEW MINERALS.—The following seven species or varieties of minerals were described in the ninth supplement to Professor Dana's Mineralogy, by Prof. G. J. Bush, and published in the May number of Sillimans' American Journal of Science.

Dianite (Von Kobell). This new mineral described by Von Kobell is a variety of tantalite, found at Tamela in Finland: the specific gravity of dianite is 5·5, and that of tantalite 7·38 to 7·5. The colour and streak of dianite is blackish grey, and of tantalite dark brownish red. Von Kobell distinguishes a new metallic acid, which he proposes to call dianic acid, in this new mineral; and he also finds it in exenite, æschinite, and samarskite.

Hjelmite (Nordenskiöld). This is a new tantalite from Kararfshof in Sweden, and is described by Nordenskiöld—the colour jet-black; lustre metallic; fracture granular; specific gravity 5·82; hardness 5·0; streak blackish grey.

Hoernesite (Haid.). A new hydrated arseniate of magnesia from the Banat. It was first recognised by Dr. Kenngott on a specimen in the Imperial cabinet of Vienna. It occurs in talc-like, stellated, columnar, and snow-white pearly masses, transparent, and optically bi-axial; the lustre on cleavage pearly; flexible. Specific gravity 2·474; hardness 0·5 to 1·0.

Melanhydrite. A new mineral found in a decomposed wacke, from Schnelzerthal, near Hounef, on the Rhine, and first described by Krantz. It is found amorphous, in irregular nodules, having a conchoidal fracture. Opaque; colour velvet-black to brownish black; streak blackish brown: it does not fall to pieces in water, and in small fragments adheres to the tongue; in composition near pelagonite.

Pinitoid (A. Knop). This is a new name to a rock-specimen from Chemnitz, in Saxony. Colour leek,- oil,- and greenish-grey, passing into white andred: specific gravity, 2·788; hardness 2·5: very closely allied to pinite.

Pisanite (Kenngott). Dr. Kenngott describes this as a cupreous variety of copperas.

Uranophane (Websky). This new mineral is from a copper-mine at Kupferberg, in Silesia; compact and amorphous. Colour honey- yellow to siskin-green, in microscopic crystals. Specific gravity 2·78; hardness less than 3·0; lustre vitreous to pearly.—J.R.G.

NEW CAVERNS IN YORKSHIRE.—DEAR SIR,—It may be interesting to many of your readers who are likely to visit Yorkshire during the ensuing vacation, to know that two new caves have recently been discovered in the mountain-limestone district of that county—one at Greenhow Hill, near Pately Bridge, and the other in Littondale, near Kilnsea Crag. The former contains some of the finest specimens of stalactites ever met with in this county, which have fortunately been to a great extent preserved from the ruthless destruction of curiosity-seekers. The cavern in Littondale has little to boast of in stalactites, but in form and extent it far exceeds that of Greenhow Hill. It has already been traced seven hundred feet into the hill, through the greater part of which distance it averages upwards of twelve feet in height, with a splendid tunnel-like shape,—indeed, through the whole length it is only necessary to stoop at one place.—Yours, &c., H. C. Salmon, Keighley.

Fruits from the Chalk.—Sir,—Do you know if any vegetable remains beyond mere fragments of wood have been found in the English Chalk?—Ed. Drake, Chatham.

Fossil-fruits have recently been found in the chalk near Rochester; and the Editor has collected some from the Lower White Chalk of Dover.

REVIEWS.

Seasons with the Sea-Horses; or, Sporting Adventures in the Northern Seas. By James Lamont, Esq., F.G.S. London: Hurst and Blackett, 1861.

It is not often that we get much geological information from the authors of "Wild Sports" in the north, east, south, and west, many as they are now-a-days. In this case, however, Mr. Lamont, though confessedly an amateur in science, knew how to use his eyes and hands, not only in stalking, harpooning, and such like, but in seeing, noting, and collecting whatever he met with of interest to the zoologist and geologist. The lively narrative of sporting adventures among the seals, walruses, bears, and reindeer of Spitzbergen, with which Mr. Lamont here supplies us, is full of natural history information, ranging from the jelly-fish to the progressive-development-theory; but geology seems to have especial charms for him—next to rifle-shooting. Without entering into all the details of the geological materials which our author has brought together, and the results obtained both by his own observations thereon, and by the exact determination of his specimens by more practised geologists, as shown in the appendix to his work, and in the Journal of the Geological Society for November, 1860, we may point out the following as the more interesting points in the work before us, as far as relates to our favourite science.

The size and conditions of some of the great glaciers are noticed, as well as the effects produced by them to some extent; the nature and relative position of the trap-rocks and carboniferous rocks (sandstone, shale, coal, and fossiliferous limestone) of the southern part of Spitzbergen; and especially the occurrence of drift-wood and of bones and skeletons of the whale, walrus, &c., on the dry land, at considerable elevations above the present sea-level; sometimes a hundred feet above the sea, and half-a-mile inland. Mr. Lamont remarks that on one of the Thousand Islands four or five miles east-south-east of Black Point, besides a great deal of drift-wood lying "far above high-water-mark, and in positions where it could not possibly have been driven by storms in the present relative levels of land and water, numbers of whales' bones also lay upon this island, from the sea-level up to the top of the rocks, which may have been thirty-five to forty feet in height. Those bones lying high above the sea-level were invariably much more decayed and moss-grown than those lower down. Some were of enormous size. In one slight depression of the island, about ten feet above the sea-level, I counted eleven enormous jaw-bones, all lying irregularly, and mixed indiscriminately with many vertebræ, ribs, and pieces of skulls. Of course it will be understood that these bones which I mention in different parts of this narrative were not fossilized. We found them in many parts of Spitzbergen, and at all elevations up to that of two hundred feet above the sea. I brought home many specimens, which are now in the museum of the Geological Society. Could an approximation to the age of these bones be in any way arrived at, they would give some chronological data for determining the time which the land whereon they are found has been in emerging from the sea and attaining its present level. My own impression, for many reasons, is that the whole of Spitzbergen has been gradually rising within the last few hundred years, and that this upheaval is still continuing. It is, perhaps, impossible to judge of the length of time which such enormous bones may endure in a climate like this, where they are bound up in ice for eight or nine months out of the twelve; but allowing, at a guess, four hundred years for bones lying at an elevation of forty feet (which is about the highest at which I have found entire skeletons), and adding twelve feet of water for the whale to have floated in when he died there, we shall arrive at *thirteen feet per century* as the rate of elevation. From the position of the eleven jaw-bones, &c., which I have just mentioned, and from the fact of so many lying together in a slight hollow, I am inclined to believe that *these* are the remains of whales killed by men, and that they were towed into this hollow (then a shallow bay) for the purpose of being flensed there. We learn from the accounts of the early whale-fishers that their usual practice was to flense their whales in the bays; and, in fact, that the whales were so abundant close to the shore that the ships did not require to leave their anchorage in the bays at all. It was about the year 1650 that the whale-fishery in the bays of Spitzbergen was in its prime; thus, supposing these whales to have been killed in that bay two hundred years ago, allowing three fathoms (the very minimum) for the ship to have anchored in, and adding the ten feet which the bones are now above the sea-level, we have twenty-eight feet of elevation in two hundred years, or very nearly the same rate as I arrived at by the other example." (Page 200, *et seq.*)

With regard to the disappearance of the whale (Mysticetus) from the shores of Spitzbergen, Mr. Lamont remarks: "I believe the principal reason to be that the seas around Spitzbergen have become *too shallow* for them: this is the general belief of the sealers frequenting the coast, only they generally 'put the cart before the horse,' by saying that the 'sea is going back.' I have heard the same remark made by the sailors and fishermen on the west coast of Norway, where Sir Charles Lyell ('Principles of Geology,' p. 506) has shown to demonstration that the coast-line is rising at the rate of four feet per century. On this island I observed a further most interesting proof of its elevation. This was a sort of trench or furrow of about a hundred yards long, three or four feet deep, and about four feet broad, which was ploughed up amongst the boulders; it was about twenty feet above the sea-level, and extended from north-east to south-west, being exactly the line in which the current-borne ice travels at the present day; so that I presume there is no doubt it must have been caused by the passage of a heavy ice-berg while the island lay under water." Thus far has M. Lamont contributed information towards the elucidation of the problems connected with the recent upheaval of the European area—a subject of high interest now-a-days, especially in connection with the question of the relative antiquity of the stone implements of human manufacture found in caves and gravel above the present sea-level.

The southern half of Spitzbergen appears to consist chiefly of Carboniferous rocks (Coal-measures (?) and Mountain-limestone), of which M. Lamont brought numerous characteristic specimens to England (now in the museum of the Geological Society); and, from a comparison of his observations with the collection of rocks made in the southern part of Spizbergen by Parry and Foster, in 1827, it would appear that the trap-rocks, sandstones, shales, and limestones of the south are represented in the north by marble and compact limestone, hard sandstone and quartzite, mica-slate, diorite, porphyry, and granite (see Quart. Jour. Geol. Soc., vol. xvi., p. 442).

Of the Permian strata Mr. Lamont found but little evidence (one rolled fossiliferous boulder), though M. Robert some years ago brought to France many fossils determined by M. de Koninck to be of Permian age. On the other hand, M. Robert's collection seems to have been very poor in Carboniferous specimens.

We observe in the list of errata belonging to vol. xvi. of the Geological Society's Journal that, in the list of specimens brought by M. Lamont from Spitzbergen, "Ammonite (?)" should be substituted for "Aviculopecten (?)" in one instance. This specimen, though doubtfully determined, appears to indicate the existence of strata of Secondary age in this arctic island.

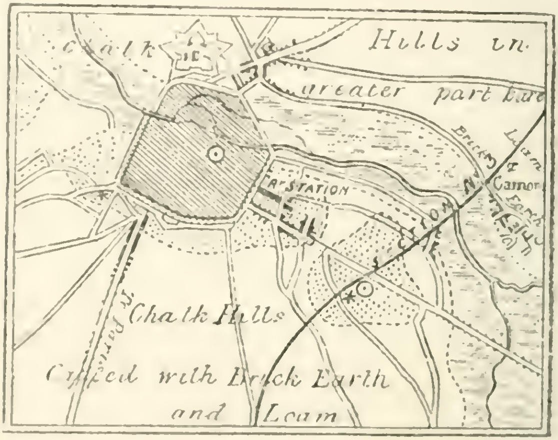
M. Lamont's interesting and instructive book is dedicated to Sir C. Lyell, with a warm acknowledgement of the pleasure derived from the "delightful 'Principles of Geology'.........my unvarying and instructive companion during ten years of adventurous wonderings,"—and with a modestly expressed hope that the author's abservations may in some way add to the strength of the arguments and demonstrations of that masterly work. That they do so, we think can be readily shown, and Mr. Lamont has our thanks for what he has already done, and our best wishes for the success of his future journeyings among the wildernesses of nature where his love of sport may lead him. To his friend, the author of the 'Principles,' also, M. Lamont's work must be one of many agreeable evidences of the goodly harvest of facts gathered by well-educated amateurs in all parts of the world, that come in from time to time as the result of geological knowledge obtained by a careful study of the 'Principies of Geology.'

SPIRIT OF GOOD BOOKS.

Private copies have been sent us of two very important papers by Mr. Evans and Mr. Prestwich, printed in the Transactions of the Antiquaries and of the Royal Societies. Mr. Prestwich's paper was read in May, 1859, and our private copy from the author reached us about a month ago. To say that it had not lost some of its interest by the long delay would not be true; for these valuable papers, instead of coming fresh in subject before the world, fall comparatively dead and flat upon the public ear, and are sought for only by the learned, who are anxious to see what emendations the authors have made in their passage through the press—what additional materials they have gathered and added between their reading and their publication. Mr. Evans was somewhat more fortunate than Mr. Prestwich, his paper being read somewhat later, and printed somewhat sooner.

We do not make these remarks to detract from the value of what these gentlemen have done, or the real worth their papers possess at this moment, but it is well to observe the misfortune to the authors themselves that by the common and general discussing of the subject during the long interval of two years, their labours originally the *first* and the most reliable should have thus lost the attraction they justly merit, and should be fated to be put amongst the heavy quartos on the library shelves, instead of being sought for and read in the family circles and homes of the inquiring and educated classes.

The great value of Mr. Prestwich's paper is in the minute details of the sections and geographical areas of distribution of the flint implement beds at Amiens, Abbeville, and Hoxne. The sections at Abbeville and Amiens are first accurately described.



Map of the Amiens' District.

"Abbeville and Amiens are both situated in the valley of tne Somme, the first at a distance of about fourteen miles, and the second of forty-one miles, from the sea. The surrounding district consists of gently undulating elevated plains of chalk, capped here and there by outliers of tertiary strata, and elsewhere partly bare and partly covered by a few feet of fine light red or yellow loam and clay, in places mixed with angular fragments of flints. The river valleys are narrow, often exhibit on their flanks thick deposits of loam and gravel, while the middle is usually a flat level of marsh and peat overlying gravel. The loam, brick-earth, or loess, forms a very marked feature in this usually bare chalk district, being principally accumulated in thick irregular and local masses on the sides and flanks of the valleys. This is especially the case for some distance both above and below Amiens, as well as up the greater number of the lateral valleys. It extends to various elevations. A bed of gravel also spreads over some of the lower hills flanking the valley of the Somme. For full particulars of the geology of the district, I beg, however, to refer to the works of M. Buteux and Dr. Ravin.

"The fall of the Somme valley is very gradual, its elevation at Abbeville above the level of mean tide of the sea being eighteen feet, at Amiens sixty feet. Between these towns the mean width of the valley, which varies but little, is rather less than a mile. The hills rise gradually to heights generally of from two hundred to four hundred feet, and nowhere exceed six hundred to six hundred and fifty feet above the sea-level, and that more in the interior of the department. The pits in which the flint implements have hitherto been observed are all in or near the main valley of the Somme.

"*Abbeville.*—According to M. Boucher de Perthes, the principal localities where flint implements have been found are, the village of Menchecourt, a suburb at the foot of the hill on the north-west side of Abbeville, the town of

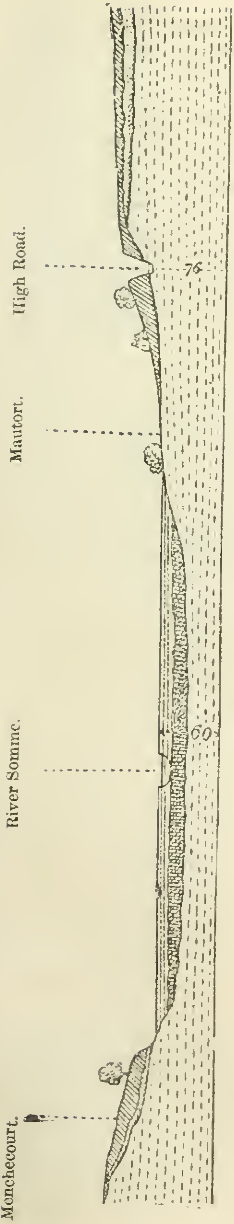


Fig. 1.—Section across the Valley of the Somme at Abbeville.

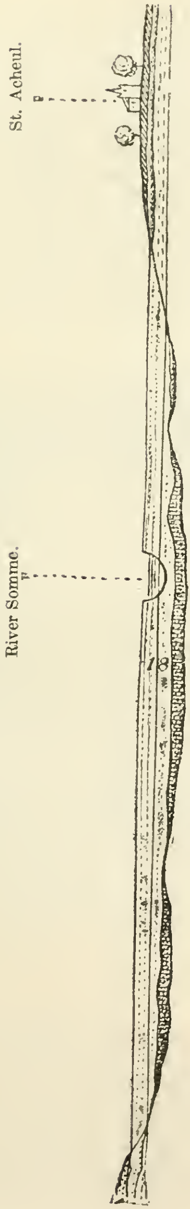


Fig. 2.—Section across the Valley of the Somme at Amiens.

Abbeville, the rising ground on the south-east side of the town on which is situated the Champ de Mars, the Moulin Quignon, and the suburb of St. Gilles, and Mautort on the west.

"There are two pits at Mautort where flint implements have been found, one a shallow one, no longer worked, in the valley near the church, and another one on the side of the hill on the road leading to Moyenville, and at a height probably about equal to that of Moulin Quignon, or about 90 feet above the valley. The section, which was badly exposed on the two occasions when I was there, consists probably of—1. Brown sandy clay and a few angular fragments of flint, 6 feet. 2. Subangular ochreous and ferruginous flint-gravel, 4 feet. 3. White and yellow sand, irregular, 3 feet. 4. Coarse light sandy, chalky, and marly flint-gravel; no bones: flint implements said to be met with at a depth of six to eight feet; reposing upon an irregular surface of chalk, 12? feet. The flint implements here are remarkable for their bright white colour. The bed of gravel ceases at this elevation, but the hill rises to a height of two hundred and fifty-two feet, showing chalk with a slight covering of red clay and flints. I also visited Druca and St. Riquier. Near the former place there is a bed thirty feet thick of sand and gravel, but we could hear of no flint implements or fossil bones. Nor were we more successful at St. Riquier, but our visit there was too short.

"Menchecourt has been long celebrated for its mammalian remains, of which a large collection was made by M. Baillon. Many of these specimens were examined and described by Cuvier. The chalk hills rise immediately above the village to the height of two hundred and fourteen feet. They are capped to the depth of a few feet by drift-loam and clays; the upper part of their slope is bare, and the lower part is covered by the deposit we have to describe, and this passes under the recent peat and silt deposits of the valley. One of the largest of the Menchecourt pits is that of M. Dufour, towards the further end of the village, and on the right hand side in proceeding from Abbeville. An extensive section of the upper beds is there exhibited. The variation in the thickness of the strata is shown in the section of M. Lereillé's pit (fig. 3), situated on about the same level, and at the further end of the village.

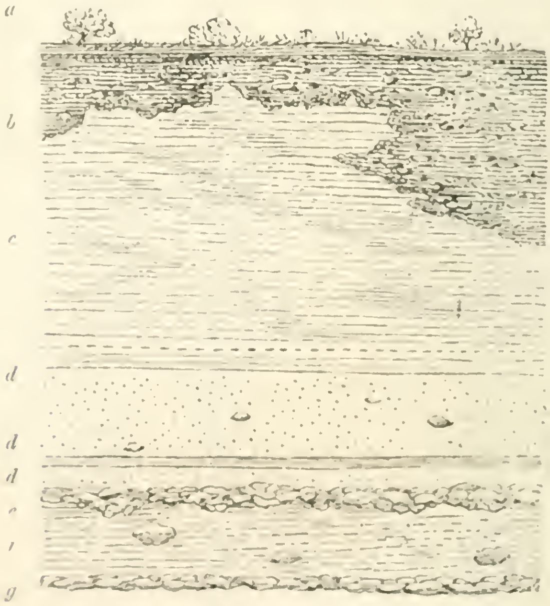


Fig. 3.—Section of a pit at Menchecourt, near Abbeville. Height of section 32 feet.

"The gravelly clay *b* becomes more persistent and thicker as it slopes down into the valley. The loam *c*, on the contrary, is cut off gradually by *b*, and thins out; its maximum thickness is from twenty-five to twenty-eight feet. The sand *d* varies from two to eight feet, and is thickest about the middle of the pit. The gravel *e* is of a nearly uniform thickness of half to one foot; it apparently does not range up to the chalk, which, at the end of M. Dufour's pit, has been met with directly under the sand *d*. Of the marl *f* I examined but few sections, as the diggings do not go deeper than *e*: it appears to be rather local. The gravel *g* was reached only in the trench opened. On the opposite side of the road to the other pit, a well was dug through twenty-five feet of gravel and sand, but no exact particulars of it were kept. A few yards beyond this the gravel passes under the great mass of silt and peat filling the valley of the Somme. In the other direction (*i. e.*, up the hill), the chalk comes to the surface at the distance of a few yards beyond and above the pits; but whether it forms a cliff against which the pleistocene beds abut, or whether it passes by a rapid slope under them, there is no evidence to show.

"No organic remains have been found in the upper clay and rubble, *b b;* The loam *c* contains a few mammalian remains. The only specimens, however, collected at present are teeth of horse and bones of ruminants and of Elephants, all much decomposed. Some flint implements are recorded from th bed, and shells of *Clausilia nigricans, Helix orbustorum, Helix hispida*, and *Pupa muscorum.* Of these the *Helix* and *Pupa* are common, and the *Clausilia* very rare.

"To the sands and gravels *d* and *e*, which may be considered as one bed, the greatest interest attaches, on account of the flint implements found in them, and the abundance of mammalian remains, land, freshwater, and marine shells. The bones mostly occur in or on the seam of flint-gravel *e*: they are often entire, but the bulk are in fragments. The land and freshwater shells are most abundant in the sand *d*; while the marine shells are more common in the gravel *e*, although a few are scattered through *d*.

"Returning back through Abbeville, and ascending the gently sloping ground on the east of the town, Moulin Quignon is shortly reached, where, at a height of a hundred and six feet above the mean level of the sea at St. Valery, is a bed of gravel showing this section.

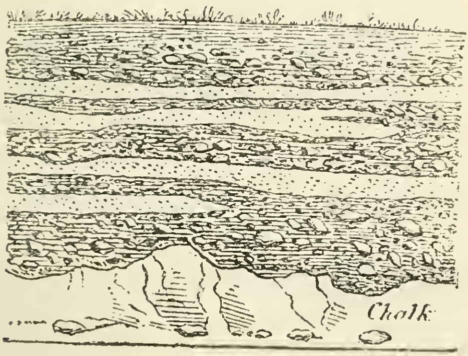


Fig. 4.—Gravel-pit adjoining the Moulin Quignon, near Abbeville.

"*Amiens.*—On the verge of the hills, and at a distance of three-fourths of a mile south-east from the railway-station, are situated the very interesting and extensive pits of St. Acheul. According to the measurements of M. Pinsard, the mean height of the ground here is a hundred and forty-nine feet above the mean tide level at St. Valery, and eighty-nine feet above the Somme valley, towards which it slightly inclines, till, as it approaches the valley, the ground falls by a more rapid and sudden slope, while southward it stretches with a gently undulating and gradually rising surface for many miles. The site of the pits is not, however, commanded by any immediate high ground, but, on the contrary, possesses an open and unobstructed view of some distance around, and is then separated, by a slight depression, from the higher hills to the southward. The pits are of considerable extent, and have been long worked for brick-earth, sand, and gravel. The total thickness of all the beds, which repose upon a very irregular and eroded surface of chalk, varies from about twenty to thity feet. The worked flints are found chiefly in the lower bed of gravel, more particularly in the lower part of it or near the chalk, where also the greater number of bones are found, but this is by no means a general rule. A considerable number of teeth and bones are also met with in the sand and marl above the gravel.

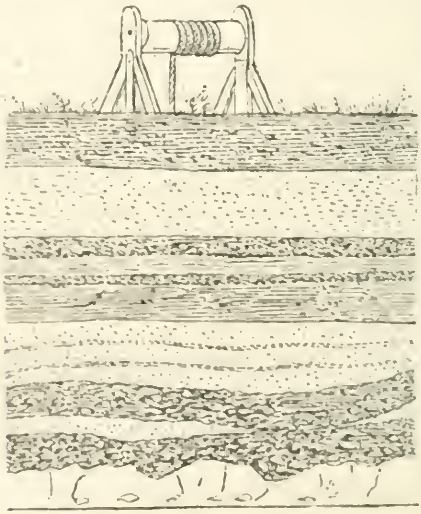


Fig. 5.—Section in a pit at St. Acheul, on the side nearest the Cagny road.

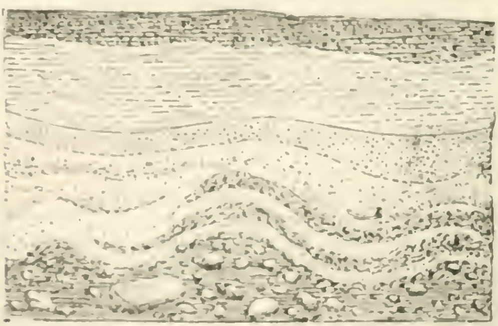


Fig. 6.—Section in a pit at St. Acheul, on the side nearest the Cagny road.

"The blocks of sandstone are very numerous and large, especially in the pits nearest the high road, some measuring as much as three to four feet in length, and weighing half to one ton.

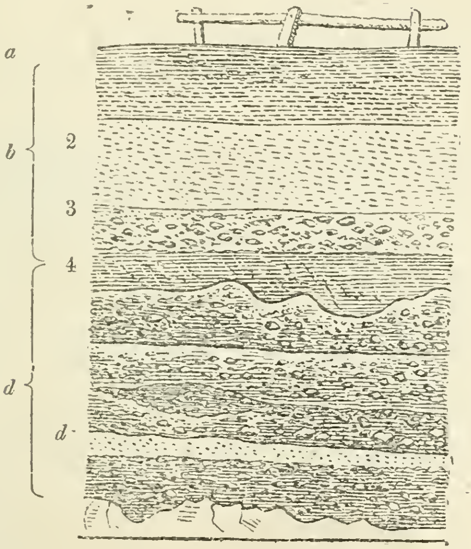


Fig. 7.—Section at St. Acheul: side of the field adjoining the Monastery.

"In the east of the field the sand *c* thins out, and is replaced by the gravel *d*, as shown in section fig. 7, where a good many remains of the elephant have been found, and but few flint implements. The beds here and throughout the field, although varying in thickness, have the same general composition as described in figs 5 and 6. (*d* is a local sand seam).

"One chief object in visiting the pits was to discover for myself, if possible, flint implements *in situ*, or failing in that, to be able to certify to their discovery by the workmen. The long fresh faces of gravel afford, together with the digging for gravel in daily operation, ready and convenient sections for observation. On my first visit, notwithstanding a careful personal search, I found neither bones nor worked flints. I, however, obtained a number of the latter from the men, some of which were dug out whilst I was there; and in the overlying sand I found numerous land and freshwater shells.

"Entire bones are comparatively rare in these pits, but fragments, more or less worn, are tolerably common. The greater number of the bones are soft, light, and friable, and without any addition to their own earthy constituents; and having lost their animal matter, they mostly adhere strongly to the tongue. Some, however, have received an additional portion of carbonate of lime, whereby their weight is considerably increased. The enamel of the teeth is generally but little changed. Some of the fossils are more or less bleached; others are coloured by the peroxide of iron present in some layers of the gravel."

In his *résumé* of the nature and value of the evidence, Mr. Prestwich says:—

"It is essential, as a preliminary step, to recollect that the argument does not rest upon the evidence of skill, but upon the evidence of design. The skill being rude (for the flints are only chipped into form and in no degree ground down) is not always evident at first sight, and hence the existence of design has been sometimes denied. Flints from the chalk hills of the district itself readily supplied the material of which the flint implements are formed. The exterior of all chalk-flints invariably presents a white earthy crust, from which small fossils frequently project, while the interior of the flint is black or dusky, but clear or semi-transparent. The fracture is conchoidal or splintery, and there is no tendency to break in one direction rather than in another. It may happen that a shattered flint (by whatever natural cause produced) should give flakes or splinters closely resembling simple forms produced by one or two blows applied artificially. But here the coincidence must cease; for it is obvious that blows applied by hazard and resulting from natural causes, as in a *mêlée* of gravel, would necessarily multiply their direction of strike in proportion as the blows themselves were multiplied, and consequently the shape of the flint would tend, up to a certain point, to become more and more irregular; whereas, on the contrary, blows applied by design, and with a given object in view, would tend to give to the flint more and more finish, form, and evident art. So with respect to the flints in the gravel the more broken the more irregular, whereas, on the contrary, with the flint implements the more they are chipped and broken the clearer is the design.

"With regard to the possibility of the flint-implements resulting from natural wear, I have already mentioned that in many of the specimens the outer coat of the flint is frequently adapted and left, when possible or convenient, in the finished instrument, and such original surfaces show so little trace of wear that small delicate fossils, so often found projecting on them, still remain untouched. If the flint had been so extensively fashioned by wear, how could one portion, and always a prominent part, have remained unworn, while other portions have been so largely abraded? Besides, the tendency of wear, if sufficiently long continued, is ultimately to reduce the flints to the rounded form of pebbles, a condition of things incompatible with the retention of the sharp points and cutting edges of these implements.

"Finally, we have to consider whether it is possible for the flint implements to have been introduced into their present position within some comparatively recent period, or whether they are contemporaneous with the accumulation of the gravel; and further, whether the remains of the large extinct mammals could have been derived from some older beds, and therefore be of anterior date to the flint implements.

"These implements might have got embedded in the gravel—1st, by artificial excavations; 2ndly, by rents in the ground. To anybody accustomed to the examination of drift deposits, there is little difficulty in distinguishing between the fresh and uniform appearance of undisturbed beds, and the mixed and confused make of made ground, independently of the occurrence of any charred materials, pottery, &c., and of bones in a comparatively fresh condition. The lines of original stratification once broken cannot be so restored as not to show the break of continuity. In the St. Acheul pits, the several divisions of the gravelly clay, b (figs. 5, 6, 7, 10, 11), and the two of the underlying sands and gravel, *c d*, each present distinct divisional lines and differences in colour. Now these lines and this bedding continue uninterruptedly over the portion of the lower gravel where the flint implements are found. There is no break, no disturbance, and the small delicate fossils in the sand *c* remain uninjured, except at such places where the ground has been dug for brick-earth or otherwise excavated, and then the disturbance is sufficiently apparent. At St. Acheul part of the field was occupied for several centuries as a Gallo-Roman burying ground. But the old sculptures rarely extend deeper than the brick-earth and gravel *b*. Some fine specimens of stone coffins (of the hard and sandy lower chalk) remain on the ground, the surrounding brick-earth having been excavated. Of the wooden coffins nothing but the ironwork remains. Roman coins, and fragments of old pottery are found on or near the surface, and the new ground is, in places, strewed with human bones. The following sections in M. Freville's pits, show how distinct the line is between the disturbed and undisturbed ground.

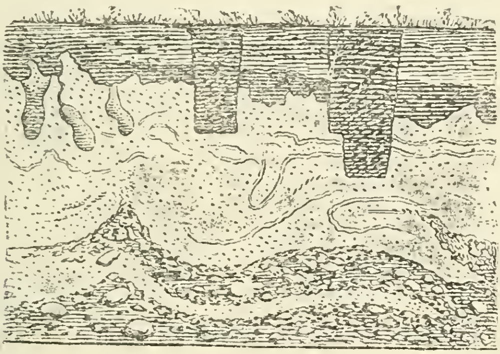


Fig. 8.—Section in the pit near the high road at St. Acheul.

"The remaining question is whether the fossil bones may have been derived from an older deposit, presents a contingency requiring especial notice. That such a case is possible is evident from the circumstance of fossils and débris of various tertiary strata being found in the gravel. Still there are, I think, valid objections to this supposition. 1. The fragments of bones, although constantly found with their sharp angles worn and blunted, never assume a rounded pebble-form, or exhibit an extent of wear materially differing from or exceeding that to which the flint-implements have been subjected; while, as a general rule, the entire bones and the teeth are either not rolled at all, or are so slightly so, as rarely to be in any way injured by attrition. If the bones were really derived from an older bed, then consequently they would in general be worn as much as any other materials derived from such a source,—a wear necessarily in excess of that of the newer portion of the gravel,—whereas, on the contrary, the bones are amongst the least worn substances in it. 2. Neither do the bones or teeth show any mineral character, nor is there any mineral substance adhering to them, different to that which would be imparted by the matrix in which they are now imbedded. Nor, if they had only been originally subjected to their actual extent of mineral change, would they have been in a better condition to resist destruction by subsequent exposure and wear than they are now. The teeth of the Elephant are mostly much decomposed, and tend, without great care, to fall to pieces on exposure. Many of the bones are also very friable, the greater number being porous and free from any foreign matter. 3. No older beds that could have furnished such mammalian remains are known to exist in the district. 4. The delicate and friable shells found associated with the bones at St. Acheul and Menchecourt, and that could not possibly have withstood any transfer, are such as are associated with similar remains elsewhere in France and in England, where we have no reason to doubt the contemporaneity of the two sets of organisms. 5. At St. Acheul part of the lower jaw with the teeth, and considerable lengths (four and five feet) of the tusks of *E. primigenius* have been found. At. Menchecourt the bones of the leg, lying in their natural position, and nearly the whole skeleton of a *Rhinoceros*, were found entire,—the first being an improbable, and the second an impossible contingency, had the remains of the animal been washed out or removed from some older deposit. 6. Lastly, the extinct mammalia are of species which occur, both in England and France, only in the latest geological deposits, whereas if these remains were here extraneous, we should expect to find some species peculiar to deposits of anterior date.

Mr. Prestwich continues, in his geological considerations of the question:—

"I should not wish, until after fuller study of the district, to enter on the question regarding the mode of formation of the above-described deposits of Abbeville and Amiens, beyond pointing out, that, at the former place, the evidence of the lower beds of Menchecourt having been deposited partly in fresh water, and partly in salt or brackish water, seems sufficiently clear and distinct. Apart from the latter condition, the St. Acheul sands (*c*), as well as the lower gravel (*d*) containing the flint-implements, may also be attributed to a like accumulation under fresh water. The upper beds (*b*) in both cases are, I believe, of entirely different origin, and belong to a class of phenomena of far wider extent and generality. At the same time, while postponing the more theoretical questions, the one concerning the relative age of the deposits can, to a certain extent, be considered independently upon the evidence of the organic remains and of correlation; and certain general conclusions may be ventured upon.

"It is probable that subsequently to that phase of the Glacial period marked by the Boulder clay, the area of dry land became more extended, and on it there lived the *Elephas primigenius* and *E. antiquus*, *Rhinoceros tichorinus*, *Hyæna spelæa*, with species of *Deer*, *Horse*, and other animals, mostly of extinct, but some of species not to be distinguished from the recent; whilst the waters of both sea and land were tenanted almost exclusively by shells of recent species still common in this and adjacent countries. The remains of this old surface we find in deposits, which everywhere contain a similar group of organic remains, and occur mostly in old valleys or at moderate elevations. They are never overlaid by other fossiliferous deposits, and I believe them all to belong to a state of things which immediately preceded the present order. One feature of these deposits is, that although closely related to the present configuration of the surface, yet they are always more or less independent of it. They are often near present lines of drainage, yet could not, as a whole, possibly have been formed under their operation. The deposits described in the preceding pages are, there is little doubt, of this age, and they have many analogues in France and England. The Menchecourt beds bear a very close resemblance (the marine characters apart) to those of Fisherton, near Salisbury. The deposit at St. Acheul is like, in many respects, the Ilford and the Brentford beds, whilst that of Moulin Quignon and St. Gilles closely resembles the gravel-beds at Croydon, Wandsworth Common, and some other places near London.

"The gravels of Moulin Quignon and St. Acheul are placed respectively eighty-eight and eighty-nine feet above the valley of the Somme, are not commanded by any higher ground immediately adjacent, and are out of reach of all running water, or of any possible interference from agents at present in action. At Menchecourt and St. Roche, on the contrary, the beds are placed against the side of the chalk hills, and slope from a height of about sixty feet down to

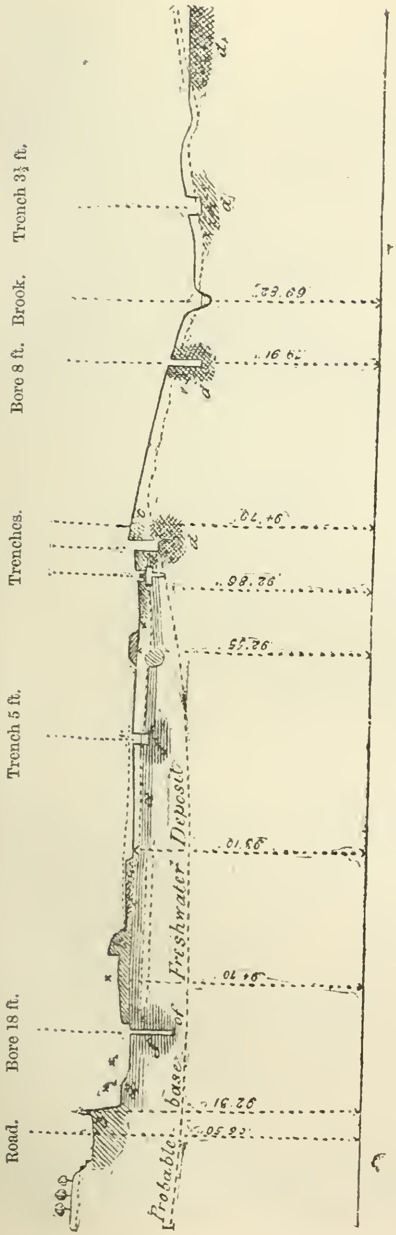


Fig. 9.—Section of brick-pit at Hoxne.
a, boulder-clay; *b*, brick-earth; *d*, bluish clay; *f*, peaty clay.

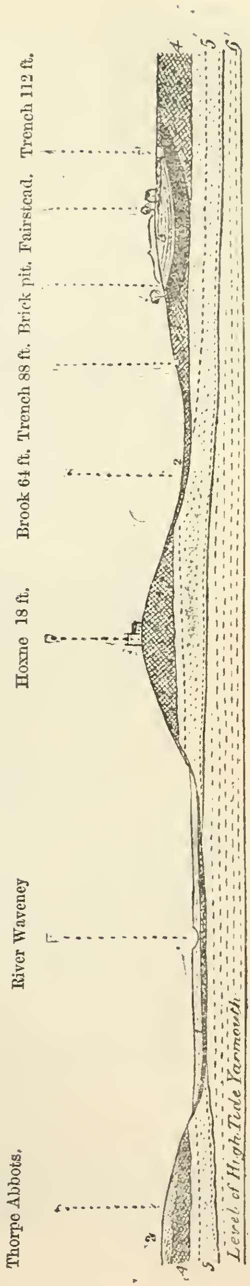
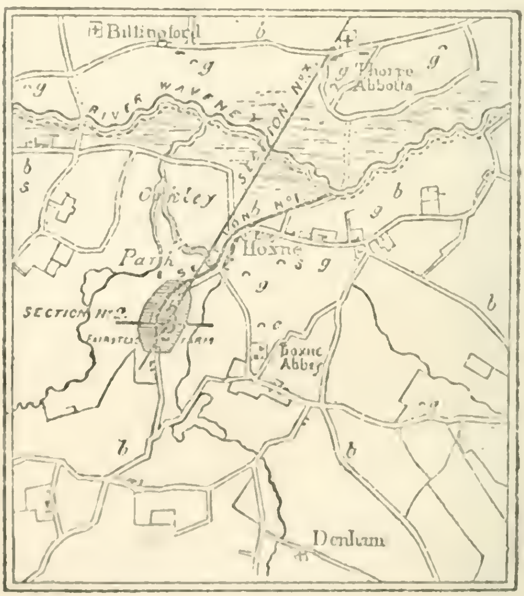


Fig. 10.—Section across the valley of the Waveney at Hoxne.

the valley. Still these lower-level deposits are, although not to the same degree, quite beyond the agency of present river action, and are independent of recent changes.

"It is probable that the various beds, although on these different levels, belong to the same general period, and may be nearly synchronous. Had I, however, been asked to decide upon physical evidence alone, I might have been disposed to consider the gravels on the low hills of Moulin Quignon and St. Acheul as a stage anterior to those of Menchecourt and St. Roch; but although I throw out the suggestion for the purpose of directing attention to the point, as one not to be overlooked, it is one which could not be decided without further evidence, and which I should hesitate at present to adopt.

"On my return from France, my attention was directed by Mr. Evans to another case of a very remarkable character, described, so far back as the first year in this century, in a paper of great value for the independent and corroborative evidence it affords, and for the bold and suggestive views of the author. Although known to antiquaries, its geological bearings had escaped notice. It relates to a discovery made, and communicated to the Society of Antiquaries, by Mr. John Frere, F.R.S., F.S.A., under the title of "Account of Flint Weapons discovered at Hoxne in Suffolk."



Map of the Hoxne district

"I lost no time in visiting Hoxne, a pretty village five miles eastward of Diss (Map, Plate xi.). The old brick pit is about half a mile south of the village, on the road to Eye, adjoining the park and on the property of Sir Edward Kerrison. It is still worked, but the section is necessarily in some degree altered from what it was in Mr. Frere's time. (For section of pit, see Fig. 11.

"The present diggings show:—*a.* Surface-soil, traces of sand and gravel. *b.* Brown and greyish clay, not calcareous,—used for brick-earth; with an irregular central carbonaceous or peaty seam. Two flint-implements are marked in the position assigned to them by the workmen, by whom they were found last winter. *c.* Yellow sub-angular flint-gravel, with a certain proportion of small chalk pebbles, and a few pebbles of siliceous sandstone, quartz, and other

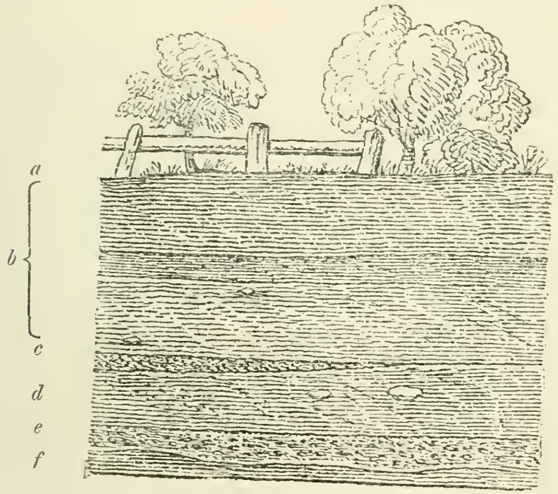


Fig. 11.—Section in south-west corner of Hoxne brickfield, 1859.

old rocks. Bones of Mammalia. The matrix of this bed, in places, consists of clay like *b*, It thins out to the westward. *d.* Bluish and grey calcareous clay, in some places very peaty; lower part with seams or partings of sand. *Wood* and vegetable remains. Land and freshwater *shells.* Bones of *Mammalia.* *e.* Gravel like *c*, but smaller, more worn, and with more chalk pebbles. *f.* Calcareous grey clay, more or less peaty, with freshwater *shells* (I had a boring made in this bed to a depth of seventeen feet, but no bottom was reached).

"I was fortunate in meeting with an old man who had worked in the pit since 1801. On showing him a small ovoid flint-implement from Abbeville, he stated that many similar stones were formerly met with here, but they were larger and more pointed. Such specimens were now rare; only two had been found, at a depth of seven and ten feet from the surface in the clay (*b*), in the course of the preceding winter, and they had not been kept. However, after a short search in a rubbish heap, the men recovered one specimen. On a subsequent visit with Mr. Evans we were more successful. We had a trench dug on the east of the field to the depth of eleven feet, and in examining the ground as it was thrown out by the men, Mr. Evans discovered in the bed of gravel, No. 4, a flint-implement perfect except the point, which had been broken off by the pick of the workmen and could not be recovered. This trench, which was of further importance as proving the superposition of these beds to the Boulder clay, gave the following section:—

1. Ochreous sand and gravel, passing down into white sand	4	9	10 feet.
2. Seams of fine white and ochreous gravel	1	3	
3. Light grey sandy clay	0	8	
4. Coarse Yellow gravel in which the *flint-implement* was found	1	0	
5. Grey and brown clay with abundance of *Bithinia* ...	2	4	
6. Boulder clay	1	0	

Both in the gravel *c* and in the clay *d* bones of mammalia are still not unfrequently met with. I obtained a fragment of a rib of a deer and part of the tooth of a horse, and I afterwards saw, in the collection of Mr. T. Amyott of Diss, the astragalus of an elephant, which from the matrix in its interstices evidently came from the bluish calcareous clay *d*. Pieces of wood, some of considerable size, are found in this latter bed. Amongst them may be recognised species of oak, yew, and fir; together with small seed-vessels. In the lower part of this bed are thin seams or partings of sand full of shells, perfect but very friable, of the following recent land and freshwater species:—*Cyclas cornea*, *Pisidium amnicum*, *Unio* (fragmentary), *Bithinia tentaculata*, *Helix nitidula*, *H. hispida*, *Limneus palustris*, *L. truncatulus*, *Planorbis albus*, *P. spirorbis*, *Succinea putris*, *Valvata piscinalis*.

According to Mr. Frere, the flint-implements were discovered in gravelly soil underlying sand with shells and bones, and overlying a peaty clay. This would seem in some, but not in all respects, to agree with either *c* or *e* of the present section. Both overlie peaty clays. The men, however, say that it is not in those beds, but higher up in (*b*) that they now find the flint-implements. The gravel *e* is below all the beds worked. I had an excavation made in it, but without success; nor was my search in the other beds more successful on my first visit.

"The general evidence of this case certainly wants the completeness which the French deposits afford, but still there is every reason to believe it to be an analogous case. Unfortunately the old part of the pit is now worked out and overgrown, but it is to be hoped that a full and efficient exploration of this interesting spot may some day be made. Mr. Evans and I had several trenches dug, but much more is yet required. In one on the south side of the field, the brick-earth (*b*) was only four feet thick, and was overlaid by three to four feet of ochreous drift-sand and gravel, and underlaid by two and a-half feet of small gravel (composed in great part of small chalk pebbles) resting upon a grey clay. The other trench, on the east side, exhibited a bed of yellow sand with a few flints, three and a-half feet thick, passing into ochreous gravel one foot, and under it a seam of grey clay one foot thick, and then another bed of gravel, at the top of which we were stopped by water. At a distance of a hundred and fifty yards from this spot, and on the other side of the small stream, is a pit in which the boulder clay is dug, and where no other beds are exposed."

(To be continued.)

THE GEOLOGIST.

AUGUST, 1861.

SUGGESTIONS ON THE PRACTICAL UTILITY OF A COMBINATION OF GEOLOGICAL SOCIETIES.

By the Editor.

We all know that whatever we do to do well we must do earnestly. It is not a thing taken in hand now and then, by fits and starts, that ever reaches the perfection necessary to give it prominence and raise it above things ordinary.

A London society, simply because it is a London society, is not therefore composed of more talent than a provincial society; nor, if it be, is that talent necessarily more effectually applied than it would be by any other society whatever. But as the metropolis is the centre and focus of the English ordinary population, so we think its learned societies ought to be the centres and foci of all the provincial societies. By this we do not advocate that the London societies should at all *control* the actions of any of the other societies; but we can not but think that the greatest good would arise from a combination of all the provincial Geological Societies and Field Clubs with that which ought to be their natural head—the London Geologists' Association. If the Geological Society itself could be made the great centre of attraction, so much the better; but the exclusive nature of that institution, and the antique system upon which its laws and regulations are founded, seem to prohibit, at least, for the present, any hope of its giving that invaluable help which it has all the materials in its hands for doing. Those means are confined as unused jewels within a strong casket by the obstructive bonds of chartered regulations. The intentional purpose of the Geologists' Association is, however, more in accordance with the wants and wishes of the Provincial Societies and Field Clubs, and it is more than probable, that had the London Association shown itself more energetic and worthy of leadership, some proposition for union and combination might have emanated from geologists in the provinces; but a comparison of the labours accomplished by the Glasgow, the Dublin, the Liverpool, Manchester, Cornwall, and Malvern Clubs would display such superior energy and talent on their parts as would rather entitle any one of them to such pre-eminence. *They* have done *much* good work. What has the London Geologists' Association to show? Surely it would not be too much at this season to expect *weekly working excursions* by the London Society? Cheap trains leave town on Saturdays in numerous directions; and even if excursion trains were wanting, ordinary fares to most of the interesting points which would be selected for a single day's work would be within the compass of the poorest of the present members, or any that are likely to join. They are such as any working man could afford. There are Grays and Ilford, New Cross and Croydon, to work at for mammalia and flint implements; Woolwich and Erith, Dulwich and Reading, for tertiary beds; Reigate and Redhill for Lower Greensand; Charlton and Gravesend for Chalk. At further ranges there are Farringdon, Hastings, Bedford, Northampton, Harwich, Dover, Herne Bay, *cum multis aliis*. But such labours must be continuous and purposeful, not desultory. Setting aside propositions for excursions such as these, would there not be a great advantage in establishing *annual meetings* of all the provincial clubs under the direction of the London Association, such as the British Archæologists have instituted for the votaries of their science. The place of meeting might be selected amongst the localities of the Field Clubs themselves, say Malvern, or Glasgow, or Manchester, or Chester, or Canterbury, or the Isle of Wight—anywhere where there was a provincial society in combination with the metropolitan head-quarters. Take Malvern first as an example. There the London Association would go, and would be joined by the Worcester, Cotteswold, Leicester, and other Societies around, and by the members of those more distant societies, such as the Kent, the Cornish, the Scotch and Irish, who felt interest in the geology of that instructive region.

Mr. Salter is now pointing out in our columns good work to be done on the Longmynds. If the London Association inaugurated an excursion *there* under *efficient leadership*, say even, perhaps, under that of Mr. Salter himself, would there not be a hundred or more geologists from all parts of England who would be ready and willing to enjoy a week's work on the mountains of Shropshire?

The constitution of the Geological Society is framed for the publishing of *accomplished* results, and there is an inherent dignity in the *fixity* of its meetings; but the geologists of the Association combined, if we understood their original purpose rightly, for mutual instruction and active work.

Let it not be understood that we are advocating *mere* gatherings. A concourse of people accumulated at one spot for the purpose of strolling over a country and dining together at the end of their ramble, does no more than promote good fellowship. It does almost nothing for science, not even so much as one stalwart arm would do in solitude by itself. But the work on such occasions should be contemplated and designed *beforehand*, and the geologists of the party should, like trained soldiers, *be each put to his proper duty.* Suppose a party of geologists at Dover, what good would they be likely to do scrambling along the cliffs one after the other? Give each member of the party a particular duty to do—a particular stratum to examine, a section to measure and draw in detail, a tract of country to examine and map. Send out an exploring party to find cuttings or sections, faults or fissures; another party to level and take dips. With such an organized party surveying the ground, marking every bed, and labelling every fossil, no field-day would be a *dies non*, but each would be "a red-letter day" for geology. If the Geologists' Association has been slothful, let them buckle on their armour and set-to even this summer. There is yet time for them to work out their proper destiny and attain their proper position. The last meeting was devoted to the consideration of the best kinds of hammers, let the next produce some scheme for using them to some purpose. We wish the Society well, and it is therefore in true friendship we urge it to assume the proper dignity of labour for which it is so admirably suited.

ON THE DEVONIAN AGE OF THE WORLD.

By W. Pengelly, F.G.S.*

The rocks composing the earth's crust contain a history and represent time—a history of changes numerous, varied, and important: changes in the distribution of land and water; in the thermal conditions of the world; and in the character of the organic tribes which have successively peopled it. The time required for these mutations must have been vast beyond human comprehension, requiring, for its expression, units of a higher order than years or centuries. In the existing state of our knowledge it is impossible to convert geological into astronomical time: it is at present, and perhaps always will be, beyond our power to determine how many rotations on its axis, or how many revolutions round the sun the earth made between any two recognised and well-marked events in its geological history. Nevertheless it is possible, and eminently convenient, to break up geological time into great periods: it must not be supposed, however, that such periods are necessarily equal in chronological, organic, or lithological value; or separated from one another by broadly marked lines of demarcation; or that either their commencements or terminations in different and widely separated districts were strictly synchronous.

One of the terms in the chronological series of the geologist is known as the Devonian, that which preceded it the Silurian, and the succeeding one the Carboniferous period; and these, with some others of less importance, belong to the Palæozoic or ancient-life epoch, or group of periods. The Devonian is, therefore, a chapter—it may be called the middle chapter—in the first volume of the organic history of the earth. It is this chapter, containing the history of the "Devonian Age of the World," which is to furnish material for this article.

The period takes its name from the fact that it represents the era

* Being the substance of six lectures delivered at the Royal Institution from May to June, 1861.

during which the limestones, slates, and associated sandstones of North and South Devon were deposited. As nearly as can be determined, contemporary rocks occur in Cornwall, Herefordshire, Wales, Scotland, Ireland, France, Belgium, Germany, Russia, Turkey, Siberia, Tartary, China, Central and South Africa, Australia, Tasmania, Falkland Isles, Brazils, and various parts of North America.

The history of the period has been largely and ably illustrated by Hugh Miller, De la Beche, Lonsdale, Sedgwick, Murchison, Austen, Phillips, Rogers, Bigsby, and many others.

It appears to have been a period in which red deposits prevailed, the colour being due to the presence of the peroxide of iron. In this respect it is contrasted strongly with the Silurian beds below and the Carboniferous limestone above; the change, however, is in neither case uniformally sudden, so that by the test of colour alone it is not easy to draw a sharp line of separation between the Devonian and the more ancient or more modern system. The red colour is less prevalent in Devonshire,—this is especially the case in South Devon, where the deposits are chiefly clay-slates, and limestones, commonly grey or more or less blue. The characteristic red rocks are well developed in Herefordshire and many parts of Scotland, where they have been carefully studied under the name of "Old Red Sandstone," a term now generally regarded as a chronological synonyme for "Devonian."

Red colours, however, are by no means confined to the period now under notice; this, indeed, is implied by the epithet "Old Red," used for the purpose of distinguishing the deposits to which it is applied from others of the same colour above, and therefore more modern than, the Carboniferous formation; and which were formerly known, as they are still occasionally, as the *New* Red Sandstone. Here, again, it was necessary to speak of the *Upper* and *Lower* New Red, now the Triassic and Permian systems.

Nor are still more modern deposits destitute of this hue, as has been pointed out by Sir C. Lyell, when speaking of the Upper Eocene formation of Auvergne.*

The thickness of the Devonian rocks has been estimated at ten thousand feet in Herefordshire; at least twelve thousand feet in Ireland, and eleven thousand nine hundred and fifty feet in North America.

Considerable variety of opinion has prevailed respecting the age of the rocks of North and South Devon and Cornwall; nor is this surprising, since they are completely isolated, frequently display great metamorphism and mechanical violence, and have very few, if any, fossils in common with rocks, now known to be, of the same age elsewhere in the British Isles. Thanks, however, to the labours of Mr. Lonsdale, Professor Sedgwick, Sir R. I. Murchison, and others, they have been determined to be, as has been already stated,

* Manual, 5th Edition, page 109.

the chronological equivalents of the "Old Red" of Herefordshire and Scotland much as they differ lithologically and palæontologically. Scotland does not yield the shells, corals and sponges so abundant in Devonshire; nor are the ichthyolites, with which the Scotch rocks teem, found in the latter district: this, however, has ceased to be a *chronological* difficulty, since the author of "Siluria" found the fossils characteristic of each of the areas lying together in the same Devonian beds in Russia.*

It is but right to add that many geologists well acquainted with the Devonshire rocks have accepted this chronological decision in a more or less modified form. Thus, the late Sir H. de la Beche regarded "The bulk of the Devonian and Cornish rocks as at least in part equivalent to the lower beds of the Carboniferous limestone, to the passage-beds between the Old Red Sandstone and Carboniferous limestone of Ireland, South Wales, &c., and also to some portion of the higher part of the Old Red Sandstones of Herefordshire and adjacent districts.' † The late Rev. David Williams considered the Devonian system as occupying "an enormous interval between the Old Red Sandstone and the Mountain-limestone."‡

The late Mr. D. Sharpe, Professor Jukes, and Mr. Austen, have advocated the view that the rocks of Barnstaple in North Devon, and South Petherwin in Cornwall, belong to the Carboniferous system; whilst Mr. Salter would modify this, and class the upper portion of the Barnstaple group only as Carboniferous. The chronology of the Barnstaple and Petherwin beds will again come under notice, when discussing the distribution of the fossils of Devon and Cornwall.

That life existed on the earth during the era of the Devonian rocks is evidenced by the fossils they contain; unless, with the author of "Omphalos," we hold them to be *prochronic*. Indeed, the introduction of life dates very much earlier than this, since no fewer than very nearly one thousand species of organisms are recorded as having become extinct in Britain alone, in pre-Devonian times. The following table exhibits the amount and variety of life in the period under consideration, as compared with the fauna and flora now existing.

The figures in the 1st, 2nd, and 6th columns are copied from Bronn's "Index Palæontologicus," Quart. Journ., Geol. Soc., vol. i., page 44; and those in the 3rd, 4th, 7th, and 8th, are compiled from Professor Morris's Catalogue of British Fossils. It has been thought best to take no liberties with the originals, so that the authors alone are responsible for the correctness of the figures, which though possibly incorrect in a few cases, are on the whole the best that can be commanded.

* "Siluria," 3rd Edition, page 382.

† Mem. Geol. Survey, vol. i., p. 103.

‡ Report Royal Geol. Soc. of Cornwall (1843), p. 123.

		Species.					Genera.		
		Living.	Devonian.	Brit. Dev.	D.&C.Dev.	Dev. Spe. / Liv. Spe.	Devonian.	Brit. Dev.	D.&C.Dev.
Plantæ	Cellulares	9,100	6	1	...	.7	2	1	...
	Monocotyledones	10,629	49	...	...	50	19	...	...
	Dicotyledones	49,674	...	...	...	...	...	...	...
Radiata.	Amorphozoa	300	11	9	9	33	6	4	4
	Infusoria	500	...	...	...	...	...	...	...
	Foraminifera	1,000	...	...	...	...	...	...	...
	Zoophyta	430	81	50	49	188	23	20	20
	Entozoa	1,500	...	...	...	...	...	...	...
	Acalepha	210	...	...	...	...	...	...	...
	Echinodermata	498	82	15	15	165	18	6	6
Articulata.	Annelida	770	8	...	...	10	4	...	...
	Cirripedia	107	1	...	...	9	1	...	...
	Crustacea	684	85	12	11	124	26	9	8
	Myriopoda	200	...	...	...	...	...	...	...
	Arachnida	600	...	...	...	...	...	...	...
	Insecta	65,000	...	...	...	...	...	...	...
Mollusca.	Bryozoa	380	56	11	11	147	22	7	7
	Tunicata	71	...	...	...	...	...	...	...
	Brachiopoda	48	131	109	108	2,729	16	17	16
	Lamellibranchiata	2,413	287	50	49	119	35	18	17
	Pteropoda	62	13	...	...	210	3	...	...
	Gasteropoda	8,822	278	47	47	32	34	14	14
	Cephalopoda	128	270	48	48	2,109	9	5	5
Vertebrata.	Pisces	8,000	110	91	...	14	47	34	...
	Reptilia	1,055	...	...	...	...	...	...	...
	Aves	7,000	...	...	...	...	...	...	...
	Mammalia	2,030	...	...	...	...	...	...	...
	Totals	171,211	1,468	443	347		265	135	97

It appears, then, that all Devonian fossils are referrible to existing *classes;* hence the organisms which long since passed into extinction, and those which now exist, are parts of one whole; and, so far as these fossils testify, there are no extinct *classes.* Of the twenty-seven classes into which the present fauna and flora of the world are divided, fifteen are represented and twelve unrepresented by the Devonian series:* the latter are divisible into three groups, namely, Minute groups, as infusoria and foraminifera; Perishable, as entozoa, acalephæ, and others; and Complex, as reptilia, aves, and mammalia. It would be premature to assert that the first did not then exist. It is a question for the microscopist; and it may be doubted whether his attention has been so far given to it as to warrant any definitive opinion on it. Perishable forms can scarcely be hoped for in a fossil state, but it is not easy to dispose of the negative evidence respecting the Complex—the higher—organisms. True, that all the Devonian beds with which we can be said to be well acquainted are of marine

* Decotyledonous fossil plants have recently been found by Dr. Dawson in the Devonian rocks of Canada. See Quart. Journ. Geol. Soc., vol. xv., page 484.

origin; that they have not been thoroughly explored; and also that the occurrence of terrestrial organisms in marine-deposits must be the exception, and by no means the rule; still, it is not easy to explain away the facts that nothing analogous to the oceanic mammalia of the existing fauna, or the marine reptiles of the mesozoic epoch, occur in these old rocks; that even fish are not met with below the very uppermost beds of the Silurian system;—the "passage-beds" between it and the Devonian series—that below the middle Silurian rocks are poor in fossils, both specially and individually, in proportion as they are ancient;—fossil-poverty being in fact a function of antiquity—that the Longmynd rocks, in no respect ill-adapted for the preservation of organic remains, have, in all their vast thickness, yielded no more than some nine or ten species; that whilst the presence of phosphates may be fairly expected in strata in which organisms were once entombed, Professor Daubeny failed to detect the presence of any such salts in the Welsh slates; unless we suppose that the most ancient fossiliferous rocks with which we are acquainted were coeval in their origin with the earliest introduction of life on the globe; that life was at first, and for a very lengthened period, represented in the world by invertebrate animals and comparatively humble plants exclusively; and that there has been, on the whole, a "progression" from simple to complex forms as we pass from ancient towards modern times.

But even if we provisionally adopt this doctrine of organic progression, it must be with important limitations and qualifications. Admitting that the evidence at present before us is to the effect that the invertebrata appeared on the stage of life long before the vertebrata; and that, of the latter fish, were introduced earlier than reptiles, which in their turn held sway in the world for a considerable period antecedent to the advent of mammals: still the humblest representatives of each class were not always the first to appear, as, for example, in the class Pisces. Amongst the invertebrates, also, the lowly classes do not invariably appear earlier, or in greater specific or individual development than those of higher rank, as will hereafter be shown.

It must be remembered also that the argument for progression is entirely negative, and would be valueless in the presence of an opposing positive fact; so that, after all, perhaps the only safe verdict in the great case of Progression *versus* Uniformity, is "Non-proven."

Of the classes represented in the Devonian series, Amorphozoa, Annelida, Cirripedia, and Pteropoda, seem to have been specifically unimportant, whilst the remainder were comparatively rich in species.* Equality in specific wealth in the various classes, however, by no means obtains now any more than in the earlier age under consideration.

In some cases it appears that classes poor then are still poor, as

* See Table 2nd column of figures.

Amorphozoa and others; others rich then are poor now, as Brachiopoda and Cephalopoda: whilst Gasteropoda, Lamellibranchiata, &c., abounding in species in existing seas, were formerly by no means thus characterized.* In order to show this numerical relation of the Devonian and existing species, the fifth column of figures, headed *Dev. Spe.*, *Liv. Spe.*, in the table, has been calculated thus:—the number of species in each class in the existing fauna, has, for the present purpose, been regarded as normal and put = 1,000, and the number in each of the Devonian classes equated to this; so that when compared with the specific development of the classes of the present day those of the Devonian age of the world stand, in ascending order, thus: — Cirripedia, Annelida, Pisces, Gasteropoda, Amorphozoa, Lamellibranchiata, Crustacea, Bryozoa, Echinodermata, Zoophyta, Pteropoda, Cephalopoda, and Brachiopoda. It will be seen also that the number of species in the two last exceeds, and in a high ratio, those of the same classes in existing seas; whilst those of Gasteropoda and Lamellibranchiata are more than correspondingly abnormally small. Here we have an example of a high class—Cephalapoda—preceding a lower one—Gasteropoda.

Though when the general fossil census was last taken, the Devonian rocks throughout the world yielded so many as one thousand four hundred and sixty-eight species;† yet if this number is considered in relation to the great thickness of the deposits of the period, the Devonian strata are poorer in species than either the Carboniferous or Upper and Middle Silurian; for example, for every one thousand feet in thickness the British Middle Silurian beds contain seventy-nine species; Upper Silurian ninety-six; Devonian forty-four; and Carboniferous one hundred and twenty. As a rule, deposits charged with peroxide of iron are poor in fossils; the red limestone of Petit Tor near Torquay, however, is an exception to this, as it is frequently crowded with Orthoceratites and other Cephalopods.

It is usual to divide the Devonian system into Lower, Middle, and Upper groups, and this triple division has been applied to Devon and Cornwall, especially by Professor Sedgwick, who recognizes the first, or lowest, in the slates and limestones extending from Plymouth to Torquay, in the limestones of Ilfracombe and Linton, the red sandstones of the north coast, and in the slates of Looe, Polperro, and Fowey, in Cornwall. This he designates the "Plymouth group."

The middle division consists of the slates extending from Dartmouth to the metamorphic schists of the Start and Bolt and the slates and purple and greenish sand-rock, stretching in North Devon from Morte Bay, east and west across the country: this is termed the "Dartmouth group," and is probably without fossils.

The upper includes the rocks ranging from Baggy point by Barnstaple, and the limestone beds and fossiliferous slates of South Petherwin in Cornwall: this is known as the "Barnstaple or

* Ibid., 1st and 2nd column of figures.

† See "Total" Table 2nd column of figures.

Petherwin group," and is not supposed to have any equivalent in South Devon.* Accepting this chronology, at least for the present, there are, when considered geographically as well as chronologically, what may be termed five fossiliferous Devonian areas in the two counties, namely, one of the "Plymouth" age, in each of the districts, South Devon, North Devon, and Cornwall; and one of the "Barnstaple" age, in each of the two last; these, as a matter of convenience, may be termed Lower South Devon, Lower North Devon, Lower Cornwall, Upper North Devon, and Upper Cornwall.

Three hundred and forty-seven species of fossils, belonging to ninety-seven genera: forty-nine families and nine classes of animals, all invertebrate, are recorded as having been found in the five areas taken together. Of these, two hundred and ninety-six species are peculiar to one or other of the areas; and the remaining fifty-one common to two or more of them. Not a single species is common to all the areas; and only one, a coral, to four of them. The numbers found in each, local and peculiar, are as below:—

	L.S.D.	L.N.D.	L.C.	U.N.D.	U.C.
Peculiar	191	5	7	50	43
Total	226	15	15	78	73

No more than eight species have been found common to Lower South Devon and Lower Cornwall, closely connected as they are chronologically and geographically. This, however, can scarcely be considered remarkable, since the mineral characters of the deposits are very dissimilar; the Cornish beds are all but exclusively slates, whilst South Devon is rich in limestone. It is not easy to account for the fact that the two contemporary—scarcely-dissimilar, and not widely-separated—deposits of Lower South and North Devon have also no more than eight species in common; and that whilst as many as two hundred and twenty-six species are found in the former, no more than fifteen occur in the latter.

The organic connection between the upper beds of Devon and Cornwall is greater than in the case of any other pair of areas, and is what might have been looked for, from the facts that they are in *all* respects closely allied.

Sixty-seven of the Devon and Cornwall species are recorded as occurring in continental Europe, and seven in North America. Six of the seven are included in the European sixty-seven, and one of the six has been found also in Australia: hence the number common to Devon and Cornwall, taken as a whole, and districts beyond the British Isles, is greater than that common to the five areas of the two counties, in the ratio of sixty-eight to fifty-one,—that is of four to three.

Of the three hundred and forty-seven species, eight are Silurian forms and fifty-eight Carboniferous; none of the former number are included in the latter. The remainder, 281, are intermediate in character to those characteristic of the two periods just named, as

* Quart. Jour. Geol. Soc., vol. viii., p. 3.

was first announced by Mr. Lonsdale a quarter of a century ago. The evidence, therefore, of the fossils on the chronology of the rocks in which they were inhumed is, first, that they are of an age intermediate to the Silurian and Carboniferous,—that is, they are the equivalents of the Old Red Sandstone, second, that they are organically connected with both these periods; and third, that the connection is closer with the last than with the first. It seems probable, therefore, that whilst there is an ample development of Middle and Upper Devonian beds in the two counties, the lower group is less fully represented, and that the lowest beds of the district do not constitute the basement of the system.

Assuming that the South Devon beds *are* more ancient than those of Petherwin or Barnstaple—and probably no geologist entertains a doubt on this point—it follows that all the fossils common to the first, and either or both of the others, must be regarded as contributions from it to them: now this number is both absolutely and relatively greater in Petherwin than in Barnstaple. Again, of the two, the latter area has contributed the greatest number of species to the Carboniferous fauna. Hence, tried by either of the above as tests of relative age, Petherwin and Barnstaple are not strictly contemporary, but the former is more ancient than the latter; which is in unison with the opinion of Sir R. Murchison and Mr. Salter, based on other and, perhaps, more reliable data.* Indeed, Barnstaple has a smaller number of forms in common with South Devon than with the Carboniferous beds; hence it may be considered as rather belonging to the latter than to the Devonian series; or, possibly may have to be regarded as "Passage beds" between them.

The Devonian fossils of Devon and Cornwall belong to ninety-seven genera, as has been already stated. Of these, twenty-four are (in Britain) peculiar to the Devonian era; fourteen common to the Silurian and Devonian; forty-one to the Silurian, Devonian, and Carboniferous; and eighteen to the two last only. Hence thirty-eight genera die out, and forty-two commence existence in the Devonian age of the world. Several of the genera of the two last divisions pass upwards into Neozoic, and even recent times. Twenty-seven genera are recorded in British Silurian and Carboniferous lists which do not appear to have been represented in the Devonian fauna; an indication, perhaps, of the "imperfection of the geological record." Few of the genera, not restricted to it, have their maximum specific development in the Devonian era, and the period is remarkable for the specific poverty of its genera; it falls below both the Silurian and Carboniferous period, and especially the latter, in both these respects. Generically, as well as specifically, the Devonian fossils of Devon and Cornwall have rather Carboniferous than Silurian affinities.

According to the catalogues Devon and Cornwall have yielded nine species of sponges, belonging to four genera; there is reason to

* Siluria, 3rd Edition, page 300.

believe that a greater number really exists. No fossils belonging to this class appear to have been found at Petherwin or Barnstaple; nor are any of the species known to belong to the Silurian or Carboniferous series. Polished sections frequently show these organisms surrounding foreign bodies, in most cases corals.

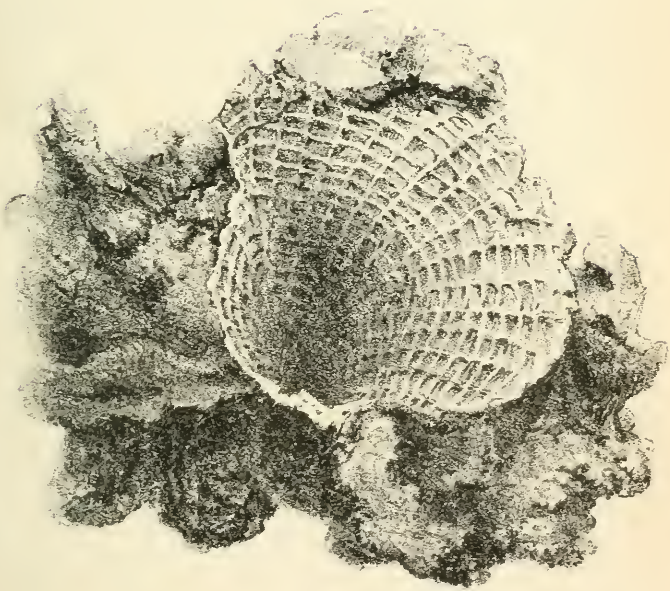
In 1843, Mr. Peach brought certain fossils, which Mr. Couch had then recently discovered in slate-rocks near Polperro in Cornwall, before the Geological section of the British Association, during its meeting at Cork. They were pronounced to be ichthyolites; and this, perhaps, the more readily from the fact that whilst the contemporary rocks of Scotland had yielded fossil-fish in great numbers. No more than, if so much as, the faintest trace of organisms of this class had been found in Devonshire and Cornwall; and this without the appearance of any reason for such absence.

Mr. Peach traced these fossils from near Fowey harbour to Talland sands, about two miles west of Looe. Subsequently they have been found, at by no means wide intervals, along the entire coast of Cornwall from Talland sands to Rame Head, near Plymouth sound. They have also been met with, but in small quantities, at Cliff on the left bank of the river Fowey, at Bedruthen on the north coast of Cornwall, and at Mudstone Bay, near Brixham, in South Devon.

Specimens were sent to the late Mr. Hugh Miller, who, at first inclined to confirm their ichthyic claims,—stating, indeed, of one specimen, that "If he had found it in the Lower Old Red Sandstone of Cromarty, he would have no hesitation in regarding it as a fragment of some dermal plate of Asterolepis;" but on receiving a larger and more complete series, he prepared a paper on them, which was read before the Royal Physical Society of Edinburgh, in which he "doubted whether their true place in the scale of being had been determined," and pronounced them "the most puzzling things he had ever seen; riddles on which to exercise the ingenuity of the paleontologist." Soon afterwards Professor McCoy and Mr. Carter subjected them to a close microscopic scrutiny, which resulted in the fossils being pronounced to be sponges merely. A new genus, *Steganodictyum*, was established for their reception, of which they were found to constitute two species, *S. cornubicum* and *S. Carteri*. These fossils are found in slate-rocks only.

The remarkable fossil formerly known as *Sphæronites tesselatus*, has also experienced a variety of fortune among systematists. Rumour says it has been assigned to *Insecta*. In a note to Sir R. T. De la Beche's paper on "The Geology of Tor and Babbacombe Bays," the late Mr Broderip says "It is not impossible that the fossil here referred to may have belonged to the *Tunicata*.* Professor Phillips, after Mr. Austen, placed it, provisionally, amongst the Sphæronites, a genus of the family Cystideæ, belonging to the Cystoidea, an extinct order of Echinodermata. Sir R. I. Murchison, more recently, says, "It is not, however, a Cystidean, that family

* Trans. Geol. Soc., 2nd series, vol. iii., part 1st, p. 161.



SPHEROSPONGIA TESSELATUS

... structure From the limestone of Woolborough near Newton Abbot

In the Collection of ... F.G.S.

Sketched ... from the Specimen by S. J. Mackie

being confined to the Silurian rocks; but is, perhaps, a complex sponge."* The fossil is, accordingly, catalogued at present under the name of *Sphærospongia tesselatus*. It occurs in the limestone beds at Lummaton, near Torquay, and at Woolborough Quarry, near Newton; one fine specimen recently found at the latter locality, shows that it is cup-shaped, the calyx, which unfortunately is somewhat broken, is elliptical,—having, at the top, its greatest diameter, about two and three-fourths inches, the least two inches, and narrowing almost to a point at the bottom. The depth of the cup is about one and a quarter inch. The walls are about one-twentieth of an inch thick; the inner surface is divided into a net-work of quadrilateral meshes, by the interlacing of, what may be termed, vertical and horizontal ribs. The former are, with slight variations, about three-twentieths of an inch apart, and are of two kinds,—primary, extending from the bottom to the top of the cup; and secondary, springing from various heights in the side or wall. The primary cycle consists of sixteen; the secondaries occur in pairs one on each side of a primary, of which they seem to be two branches issuing from the same node; these, in like manner, occasionally give off similar branches. The horizontal ribs are less prominent, somewhat thinner and closer than the verticals; they are about one tenth of an inch asunder. Not unfrequently some irregularity is observable in their arrangement, being occasionally more or less out of horizontal, and not always at quite the same level on the opposite sides of the same vertical; so that as often as otherwise, they are not in one and the same straight line. In fact they sometimes remind one of the "bridging-pieces" which builders insert transversely between the flooring joists in houses for the purpose of securing stability. The surfaces of both sets of ribs, as well as the interstices, are covered with granules. Imagine the cup to be a gigantic calyx of some species of coral belonging to the sub-order *Zoantharia tabulata*, as, for example, *Heliolites porosa*; then do the vertical ribs represent the rudimentary septa, and the horizontal ones the tabulæ, which must be considered as rudimentary also.‡

The beautiful specimen of this fossil figured in the Transactions of the Geol. Soc., vol. iii., part 1st, plate xx., fig. 1; and also in Professor Phillips' "Palæozoic Fossils," plate lix., is lodged in the Jermyn Street Museum.

The genus *Stromatopora*, formerly regarded as belonging to the corals, but now removed to the sponges, contain five Devonian species, all of which appear to be confined to British localities, with the exception of *S. concentrica*, which occurs also in the Eifel. It is extremely abundant in the South Devon limestones, and not unfrequently attains a very great size.

* Palæozoic Fossils, p. 135.

† Siluria, 3rd Ed., p. 298.

‡ This is merely meant as illustrative, and not as a suggestion that the fossil is a coral.

In the Devonian deposits throughout the world about one hundred and fifty species of fossil corals have been found, forty-nine of which occur in Devon and Cornwall. Twenty-three of these are found in continental Europe, and six in America; five of the six are included in the European twenty-three, and one of the five has been met with in Australia. The British Devonian corals belong to twenty genera, six families, and the three sub-orders, *Zoantharia tabulata*, *Z. perforata*, and *Z. rugosa*.

The genus *Favosites*, belonging to *Z. tabulata*, contains five species, all of which have a wide geographical range. *F. Goldfussii* frequently attains a very large size; masses upwards of two feet in diameter are sometimes met with. It is also remarkable for its great distribution in space, occuring in Devonshire, at Nehou and Visé in France, at at Millar in Spain, in the Oural, in the states of Ohio and Kentucky in America, and in New South Wales; yet it was confined to the Devonian era. It was formerly confounded with *F. Gothlandica*, a Silurian species. *F. cervicornis* is remarkable for its great abundance in certain localities: at East Ogwell, near Newton, a very considerable mass of limestone seems to be entirely composed of it, to the almost total exclusion of other fossils. *F. fibrosa* occurs also in Lower Silurian rocks in South Wales, and in Upper Silurian in Shropshire.

Pleurodictyum problematicum is the only species, not only of the genus, but also of the family (*Poritidæ*), and even the sub-order (*Zoantharia perforata*) which occurs in Palaeozoic rocks, all its affinities are with organisms of much later times: it is a small islet of vitality, separated by a vast ocean of time from the organic continent to which it belongs. In Britain it occurs in the slate rocks at Meadfoot, near Torquay; at Ogwell, near Newton; and in great abundance, and of great size, at Looe in Cornwall; but has not been found anywhere in limestone.

The genus *Cyathophyllum*, belonging to the palaeozoic sub-order *Z. rugosa*, contains fourteen species, that is, two-sevenths of the entire series. A small reed-like variety of *C. cæspitosum* occurs in such numbers at one locality known as the Land's End, near Torquay, as to furnish a very faithful example of a coral-reef of the Devonian period. *C. Bucklandi* is the only British Devonian coral not found in South Devon.

Chonophyllum perfoliatum is recorded as occurring in Upper Silurian rocks as well as in Devonian; its great vertical range suggests the belief that it possessed a hardy plastic constitution, seeing it had lived through changes such as must have been introduced during lapses of time great as those represented by the terms "Silurian" and "Devonian;" and from such a constitution it might be supposed to have had a wide geographical distribution; nevertheless, it seems to have been particularly limited in this latter respect, thus contrasting strongly with *Favosites Goldfussii*, which, as has been stated, circumnavigated the globe during the Devonian age, to which it was confined; whilst *Chonophyllum perfoliatum*, which

Fig. 1

TRIMEROCEPHALUS LÆVIS. (perfect)

Volcanic Ash, Knowle Newton Bushell S. Devon.

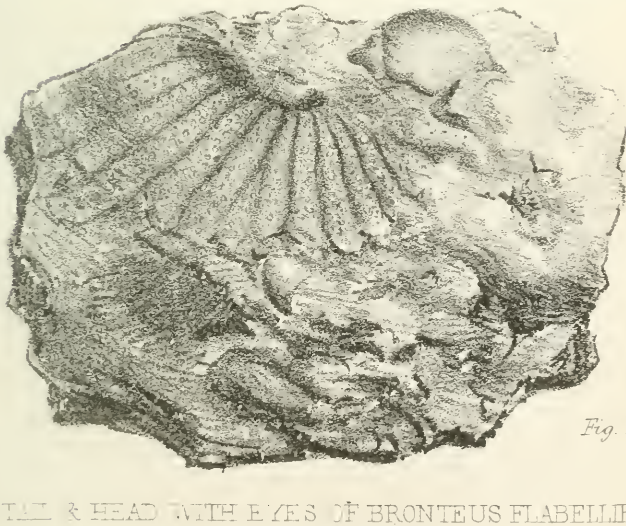


Fig. 2

TAIL & HEAD WITH EYES OF BRONTEUS FLABELLIFER

Limestone, Woolborough,

Near Newton Abbot, S. Devon.

Sketched from the Specimens

On Stone by S. J. Mackie, F.G.S.

formed part of both the Silurian and Devonian faunas, was confined to a very limited district in each period.

Blastoidea and *Crinoidea* are the only orders of Echinodermata found in Devon and Cornwall; the first is represented by a single species, *Pentremites ovalis*, and this is only met with in the Barnstaple area; it occurs also in the Carboniferous period, as do all the other species of the genus.

Fourteen species of *Crinoidea* belonging to five genera and two families have been found in Devon and Cornwall; two of these occur also in continental Europe in rocks of the same age, and five in carboniferous beds; but not one seems to have been derived from the Silurian series. Parts of the stems are extremely numerous occasionally, both in the slates and limestones; bodies are very much less frequently found, and arms seldom if ever. Good examples of the body of *Hexacrinus interscapularis*, but without stem or arms, have been found in the Woolborough quarry near Newton.

Excepting *Cypridina serrato-striata*, found at South Petherwin, all the crustacea of the two counties are Trilobites. No traces of Pterygotus, Eurypterus, or Estheria—found in other British Devonian localities—have been met with. The trilobites belong to ten species, seven genera, and six families; hence the genera and families are very limited in specific development. With the single exception of *Phacops granulatus*, found at Petherwin, they all occur in South Devon, and are all confined to the Devonian era excepting *Phillipsia Brogniartii*, which is also met with in carboniferous beds in many and widely-separated European localities; this was eminently a carboniferous genus having no Silurian representative, but in all other cases the generic affinity was with the Silurian age. Indeed, the trilobitic form of life had passed its culminating point before the commencement of the Devonian age of the world—the evening of the group had already begun: no fewer than a hundred and seventeen species had previously become extinct in Britain alone; of these, ninety-eight belonged to twenty-one genera and seven families, which had also entirely disappeared from the earth.

Phacops latifrons occurs in the calcareous slates at Roseland Vale, near Liskeard, in Cornwall, where it seems to have attained considerable dimensions: in many cases the eyes, though somewhat flattened, are otherwise well preserved, not a facet being scratched. It has also been found at Croyde and Barnstaple in North Devon, and in clay-slate at Black Hall, near Totnes.

The tail of *Bronteus flabellifer* is by no means rare in the limestone of Woolborough, near Newton, and Lummaton, near Torquay; no part of the thorax seems to have been met with, but one example of a tolerably distinct head with eyes was found at the former locality.

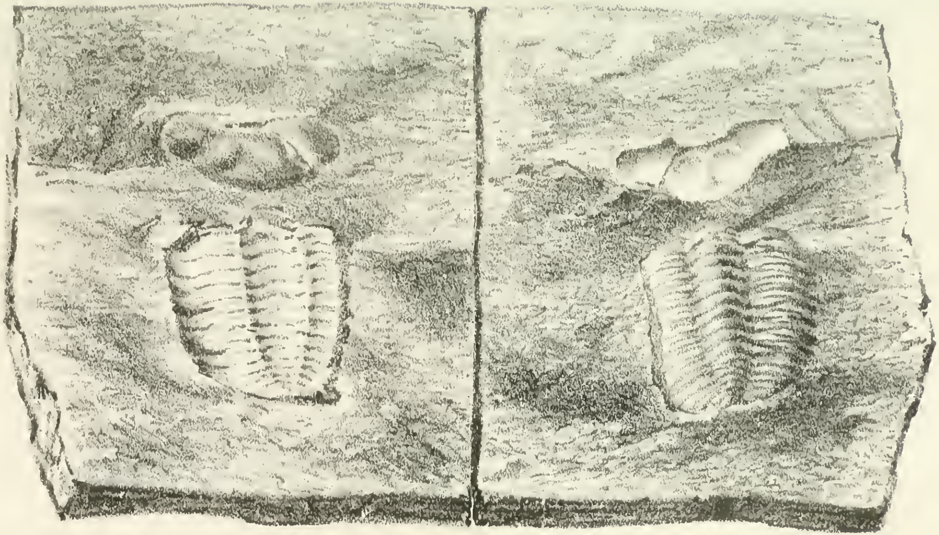
Trimerocephalus lævis, the only British species belonging to the genus, occurs under somewhat remarkable circumstances. So far as is at present known, it has been found only in one locality, namely, on the flanks of a hill called Knowles, near Newton, and no other fossil of any kind has been seen there. On this point our knowledge is expressed by saying there is but one locality for the fossil, and but one fossil for the locality. Many hundreds of specimens have been found and but two instances are known to have occurred in which the head was attached to the thorax. On splitting a stone, and thereby disclosing one of these trilobites, except in the two cases just named, the head is not visible; or what is much more frequently the case, one half the stone is found to contain the thorax and tail united, and the *impression* of the head, whilst in the other half are found the head and the *impression* of the body, and always in such a way as to show that the head had been severed from the body, removed a short distance from it, as if drawn or pushed forward, and inverted. In the cases where the head has not been visible, it has generally happened that it has been concealed by a mere film of the imbedding matrix, and can be found with a little care. When so found it tells the same story. There are never any indications of eyes; not unfrequently the tail appears somewhat truncated, as if its terminal margin were slightly folded or tucked under. It is clear that an inversion of the head might have been effected by a semi-rotation either at right angles to the axis of the body or in the direction of that axis; but as the *anterior* margin of the head is always found nearest the thorax, it is clear that the motion must have been of the latter kind. The rock in which the fossils occur has been pronounced by Mr. Sorby and others to be a volcanic ash, and this without reference to, or knowledge of, any speculations respecting the facts connected with the trilobites. Knowles Hill, on the flanks of which they occur, is a mass of greenstone, and is marked as such in the map published by the Geological Survey.

According to Burmeister, it is probable "that these animals (trilobites) moved only by swimming; that they swam close beneath the surface in an inverted position, the belly upwards, and the back downwards, that they made use of their power of rolling themselves into a ball as a defence against attacks from above; and that they lived gregariously in vast numbers, chiefly of one species."*

The facts connected with this fossil seem capable of explanation by supposing that a shower of volcanic ashes, falling into the ancient Devonian sea in the Newton area, alarmed a shoal of these trilobites just then swimming by, and thereby caused them instinctively to roll themselves up for defence; that the continuation of the shower, and possibly the presence of noxious gases, killed the unfortunate crustaceans in the rolled-up posture; that their centre of gravity was so situated as to cause them to sink to the bottom on their backs; that they were inhumed in the heap of ashes, which, by accumulating very rapidly in great quantity, produced a pressure sufficient to flatten the body, and, with very few and slight exceptions, the tail also; to dislocate the head (the line of union of the head and body being the line of least resistance), and, after the manner in which slaty cleavage in rocks is probably produced, to thrust it some

* Burmeister's "Trilobites," Ray. Soc. p. 52.

Fig. 2 Fig. 1

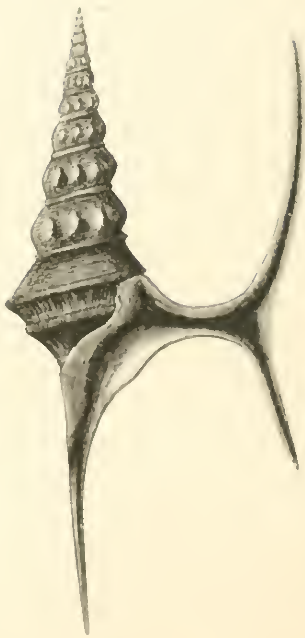


TRIMEROCEPHALUS LÆVIS.

Fig. 1 Body and impression of head

Fig. 2 Head and impression of body shewing the condition in which the fossil invariably occurs.

Volcanic Ash, Knowle, Newton Bushell, S. Devon



ROSTELLARIA CARINATA.—Mantell.
From the Gault, Folkestone.
In the National Collection, British Museum.

[illegible] del. [illegible] Woodward Direxit.

little distance forward from the body. By such a process, the head would be inverted, and in such a way that the severed parts would take the relative positions which have been described.

All the British Devonian Cephalopoda are *Tetrabranchiate*, and every family of the order occurs amongst them. *Nautilidæ* is represented by two genera, *Clymenia* and *Nautilus*. The former contained eleven species, all confined, in Devon and Cornwall, to Petherwin. The genus appears to have been restricted to Devonian times. *Orthoceratidæ* also had two genera, *Orthoceras* and *Cyrtoceras*. The first contained twelve species, of which one is recorded as occurring in continental Europe, and three in carboniferous rocks. It does not appear that any have been found in Lower Cornwall or Lower North Devon. They differ much in the inclination of the sides, the septal distances, the situation and character of the siphunculus, and the inclination of the septa to the sides of the shell, though it is *possible* that the obliquity of the septa may have been caused by distortion, it is scarcely *probable*, seeing that in different specimens from different localities the amount or degree of obliquity appears to be constant. In one species the siphunculus is remarkable as forming a discontinuous line in passing from chamber to chamber. This genus was richer in species, and many attained a larger size in the Silurian and Carboniferous, than in the age under consideration. *Cyrtoceras* had thirteen British Devonian species, all of which, excepting only *C. rusticum*, probably a synonym for *Orthoceras arcuatum*, are in Britain confined to South Devon. Species belonging to this genus occur before and after, but it attained its maximum specific development in, the Devonian age. The family *Ammonitidæ* was represented by the single genus *Goniatites*, the first born of the family, and which dates its advent in this period, when, in the British isles, it numbered ten species, all of which are met with in Devon and Cornwall: one of them occurs in continental Europe, and three passed upwards into Carboniferous times, when the genus attained its maximum development; it outlived the Palæozoic epoch, and finally disappeared in the Triassic period.

Want of time has rendered it necessary to pass over the other classes of mollusca, as well as the entire flora of the period; and from the same cause attention has been mainly given to the Devonian beds of the South of Britain.

Though, with the exception of a scale of *Holoptychius*, found, according to Professor Phillips, at Meadfoot, near Torquay, and another at Baggy point, in North Devon, ichthyolites are not recorded as occurring in the Devonian rocks of Devon and Cornwall, it is nevertheless certain that fish did exist within the area during the period under consideration; as a fossil found a few years since in the *Steganodictyum* beds near Looe, in Cornwall, has been pronounced by Sir Philip Egerton and other eminent palæontologists to be an ichthyodorulite, or defence-spine of a fish; and it is probable that other, though less well marked, specimens have been met with in the same district.

The age of the world, then, which we have been considering, was comparatively a very early one; prior to the growth of that flora of unparalleled luxuriance which has been transmuted into coal, and the deposition of the iron-stone so frequently, and in such abundance, found interstratified with the coal-beds; a period earlier than that in which were elaborated and localized so very much of the materials containing that force, and strength, and durability which give a form and character to the civilization of our own times;—anterior to those pages, at once historical and predictive, in which was pre-written so much of the history of countries and nations then very remotely distant in the future, and seen only by the eye of Prescience.

Yet it was by no means the *infancy* of the world; it had been preceded by times of vast duration, represented by miles, in thickness, of sedimentary rocks; all necessarily presupposing denudation, and, therefore, an equal amount of still more ancient rocks; earlier times so great that in the area of modern Britain alone very nearly one thousand organic species—a thousand distinct forms of life—had performed their parts and passed into utter extinction; not only species, but genera, families, and even orders had entirely passed away; the world had already become old to, and for, them; the external conditions to which they were adapted had disappeared, and had compelled their withdrawal also—gradually, slowly, and successively; whilst their vacated niches were, one after another, occupied by new forms adapted to the new circumstances.

That the age was itself one of incalculable duration is evidenced by the facts that in some localities it is measured by fully two miles, vertical, of sedimentary matter, eminently and unmistakably detrital; and in others by vast piles of limestone, the result of the slowly constructive labours of the small coral polype. If we may assume that then, as now, reef-building corals did not labour in depths exceeding from twenty to thirty fathoms, we are furnished with a sounding-line that enables us to fathom seas that no longer exist; and since, in some instances, those limestone beds make up an aggregate thickness very greatly exceeding this, yet every stratum clearly the product of long-continued polype labour and industry, it appears that the Darwinian hypothesis of areas of slow and long-continued subsidence which so felicitously explains the phenomena of the coral-reefs of the Southern ocean, is equally applicable to, and equally required for, similar phenomena in the British area during the Devonian age of the world.

That it was a distinct organic period is seen by its fossils, for the most part peculiar and characteristic, yet intermediate in general facies to those of the Silurian and Carboniferous ages; but it was not isolated from either, as some of its forms of life were derived from the former and a still greater number transmitted to the latter: the three great Palæozoic periods graduate into one another, blending as softly as do the tints of the rainbow, and emphatically deny that from the commencement of the first to the termination of the last

ICHTHYODORULITE FROM THE CHLORITIC SLATE OF LOOE, CORNWALL.

In the Collection of W. Pengelly, F.G.S.

Sketched from the Specimen
On Stone by S. J. Mackie, F.G.S.

there was any universal synchronous catastrophe or cataclysm such as to depopulate the entire world.

From some cause, at present unknown, and perhaps even unguessed, it was not an actively vital period; in fact, it fell below what may be called the normal degree of organic productiveness. Compared with those above and those below, its strata are poor in fossils in proportion to their thickness, and the genera are similarly sterile in species.

Possibly the climate was somewhat warmer than now, though the evidence of this is very treacherous. Exogenous trees existed then, and by their rings of woody matter, implying activity and stimulus, and the separability of those rings, indicating rest and the suspension of the force which causes growth, suggest the idea of changes of temperature characterized by periodicity—in fine, a change of seasons; the earth travelling round the sun under the influence of his attraction, and having then as well as now her axis inclined to the plane of her orbit.*

The beautiful patterns of the coral genera, *Heliolites*, *Acervularia*, *Smithia*, *Spongophyllum*, and others; and the exquisite forms of the *Crinoidea*, are so many revelations of the existence of beauty in those early *pre-human* times. So far as man is concerned—

> "Full many a flower is born to blush unseen,
> And waste its sweetness on the desert air."†

And then, too, animals were furnished with weapons and other means of *defence*, implying the co-existence of organs of *offence*. Violence, Fear, Terror, and Pain occupied the earth; the threads of Death were from the first inwoven in the web of Life, and the commission "to kill and eat" is as old as the organic creation.

FOSSILS IN THE "AZOIC" ROCKS.

Sir,—I hasten to communicate a new and most interesting fact regarding the oldest rocks; and I do so for the sake of securing the credit of its discovery to the excellent Keeper of the paleontological collection of the Royal Bohemian Museum, Prague—Dr. Antonio Fritsch, who well known on the continent as an authority on birds, is also an ardent paleontologist. Three summers back, he went over with me the old Silurian ground of Shropshire and the Malverns, and he convinced me that he knew his own rich district well, by the frequent comparisons he made between the different parts of

* Dr. Dawson, Quart. Jour. Geol. Soc., vol. xv., p. 485.

† Testimony of the Rocks, p. 241, &c.

it and our British strata. Except M. Barrande, indeed, the prince of paleontologists, no one has entered more heartily into Bohemian geology, especially of its older rocks, than my friend. We visited all the principal silurian localities together, Dr. Fritsch commenting as he went, till we came to the venerable "Stiper Stones" and the overlying Tremadoc rocks of Shelve in Shropshire. Even these last, though they have not yet distinguished them by a separate name in Bohemia, he recognised as identical with the lowest bands of their second fauna *D*, and in the main I believe he is quite right

The Lingula flags we were unable to visit, but Church Stretton was within reach; and when, on the very last half-day we had to spare, we walked up the Carding Mill brook and found the *Annelides* in place, he could scarcely believe his eyes.

There they were, however,—the certain records of a sandy shore gone by. And we obtained enough to convince him that it was worth while to search his own "azoic" rocks. He has lately been appointed to a new office in the Museum, but has used the little leisure accorded him to search carefully for these old traces. In a letter received to-day (July 8th) he tells me "In our Cambrian stratum *B* I have at length found marks of annelides! and I beg you to write me in what book you have published the *Arenicolites sparsus* from Church Stretton."

Dr. Fritsch's Sketch of Bohemian Arenicolite.

All doubt is set at rest by the slight sketch he has sent. There are the double holes characteristic of these old worm burrows. The tubular hollows leading to them are seen on the sides of the slab, and are identical with those of the *Scolithus* or *Arenicolites* figured in Hall's American Paleontology, or in the last edition of "Siluria."

So certain is it, that steady research will be rewarded in the most barren formations. Now the same diligence must be given by our Canadian cousins to the Huronian rocks of Lake Superior. In fact, we must leave off calling rocks *azoic*. They only want hunting, in proportion as they are old.

I believe most fully that these coincidences in organic remains over wide areas are not accidental. The fauna of the "zone primordiale" or Lingula flags, has turned up the same great group of trilobites wherever it has been searched; and this, which is an older formation still (perhaps much older), has shown, wherever it has been carefully examined, an extraordinary abundance of worm-burrows, to the exclusion almost of all other forms. I expect, however, to hear of *Oldhamia* and *Palæopyge* next, for Dr. Fritsch is not the man to leave a stone unturned. It is altogether a most welcome piece of information.

Now the summer months are fairly in, and the holidays beginning, may I put in a plea for the Cambrian rocks of the Longmynd? The more hammers the better; and if every piece of rock on the top of Round Hill, just beyond Callow Hill, were examined for the *Palæopyge*, it would be worth while; or better still, the neighbouring gullies on the line of strike. The old marks of hammers will easily guide explorers; and the establishment or refutation of the existence of this, the oldest of all crustaceans, would be alike desirable.

J. W. Salter.

HUMAN REMAINS IN THE DRIFT OF THE VALE OF BELVOIR.

Dear Sir,—In accordance with my promise, I send you all the particulars I can glean relative to the human skull said to have been found in the valley of the Trent, near Newark, many feet down in the drift, and mingled with bones of extinct mammals. Of the vast importance of such a discovery I was fully aware, therefore immediately my friend W. Ingram, Esq., of Belvoir Castle, laid the circumstances before me, I, perhaps somewhat too hastily, sent off an account thereof for your magazine. Of that, however, your readers must judge. I knew that M. Boucher de Perthes has, in the editions of his descriptive works on the "Flint Implements," repeatedly said, in answer to the taunting question of his theoretical opponents, "How is it you never find the bones of man with these flints and bones?"—"Wait! They must be present somewhere. Wait and they will yet be found." During the last few years numerous results have issued. Mr. Horner's researches in the valley of the Nile sufficiently prove the great age of man, and the large extension required beyond the six thousand years of Archbishop Usher. If the story of the flint-implements be true, the history of man upon the earth must date back to a period immensely remote. Moreover, the length of time indicated by the heiroglyphics of Egypt and the calculations of the Chinese is by these discoveries verified. After years of pooh-poohing, *facts* have transpired in quick succession, establishing what before was for the most part theory founded upon inferences; and now, upon the same old inferences, theories are drawn out and built up in a new way to prove the lowness in the scale of intellect of the makers of the flint-implements; in other words, that that race of men was in the scale of being the step between the gorilla and the "nigger." And what for? Simply to prove the development theory of the "Vestiges," Lamarck, and so on back to the time of Democritus; for these development theories are not new to the world: they are the old hypothesis dressed up in a new fashion. However, as it is not my purpose at present to dispute the ancestry some modern authors have chosen for themselves, I pass on, especially as I have a strong personal objection to any such lineage for myself.

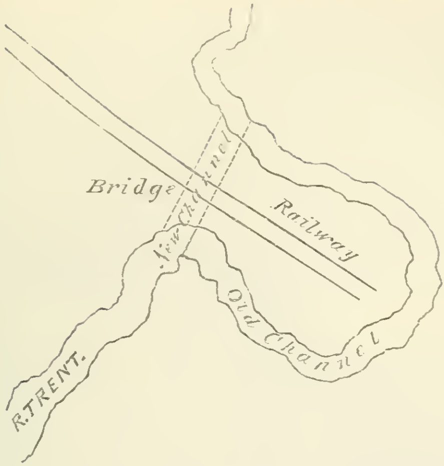
On Monday the 17th inst. I set out in company with Mr. James Plant, of Leicester, for Belvoir Castle. We walked across the country from Melton to Croxton, where a friend met us for the purpose of driving us to some of the localities in the neighbourhood best adapted for geological observation, the weather being all a geologist could desire. We were tolerably astounded at the immense mass of typical Lias fossils which we saw near the village of Redmile; *Ammonites*, *Terebratula*, *Rhynconella*, *Plagiostoma*, *Pecten*, *Modiola*, *Belemnites*, *Gryphea*, *Avicula*, and fossil wood and coprolites being met with in abundance. Hugh Miller has told us how he was enchanted with and enchained in the Wren's-nest at Dudley by a slab of Silurian limestone crowded with the remains of palæozoic life. So similar sensations crept over myself in this liassic burial ground. Thence we passed to another interesting locality at Woolsthorpe brickyard, where some beautiful specimens of *Ammonites*, *Pentacrinites*, and a variety of other fossils may be found in the Lias clay. These are exceedingly delicate and small, but not friable. We visited other places more or less interest not necessary to describe here, and the next morning proceeded to Newark, to inspect, if possible, the bones and skull referred to in my last communication; but in this we failed, as their owner, Dr. Beevor, had sent them to be made into a hat and cloak stand for his hall, placing the skull on the top. A singular appropriation, which can only be accounted for by the fact that the doctor takes no interest in geological matters, and was not aware of the scientific value of the bones

He has, however, promised to forward them to Mr. Ingram of Belvoir, who will forward them to you for inspection.

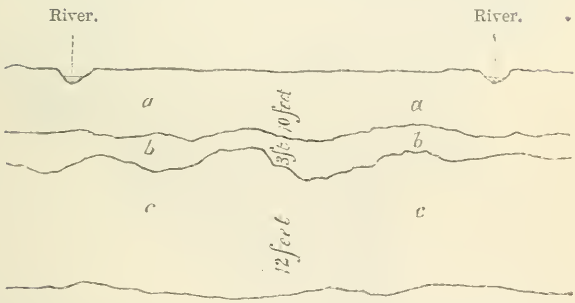
The particulars I give below are well substantiated, and not the slightest doubt can by any means be thrown on them, as the facts are all well attested. The following is a rough sketch of the district, showing the bends of the river. The Great Northern Railway diverted the course of the river to the channel shown by the dotted lines, and in digging for the foundation of the bridge over the new channel the workmen came upon the remains in question.

The whole of the operations were on Mr. Chowler's farm, at Muskham, near Newark, and I ought, in justice, to remark that Mr. Chowler was exceedingly kind and polite in affording us all the information we required.

The section shows the depth at which these bones were come upon, to be much greater than was stated in your June number, being twenty-five feet instead of twelve feet.



Plan of the district at Muskham, near Newark.



Section across the locality where the bones and human skull were found.
a, loam; *b*, clay; *c*, pulpy silt, very soft, and gravels.

The pit sunk was about fifteen feet square, and at the bottom a ten feet rod could be driven in with the hand alone, so soft was the material. The divisions between the loam, clay, and silt had never been disturbed from its first deposition. This was particularly noted. Within a few yards of the spot this soft stuff gave place to fine gravel and sand, the clay and loam continuous as before. In some portions of this valley the gravel and sand comes up to within a few inches of the surface, and the clay is wanting; but this is not the case in this immediate locality. This soft. pulpy matter indicates a percolating connection between the "reaches" and the river. Suffice it then to say that at this depth of twenty-five feet, the antlers of a reindeer were found four feet long, sundry other large bones, supposed to be those of *Bos Elephas, Equus*, &c., and numerous coprolites (?), or more probably fossil fruit; also a very rude earthenware vessel, in size about a pint and half, and a human skull, which Dr. Beevor pronounces to be that of a female. What is very remarkable, he says the organs of caution and firmness were very largely developed, and the forehead was lofty, evidently betokening a high degree of intellectual power. Now this is the most important thing in the whole matter, because it clashes so discordantly with the theory that man of the flint-implement period of the "drift" was so low in the scale as necessarily to come in between the gorilla and the negro. Alas! for the theory, if this, the only human bone yet found, so flatly contradicts it.* We can still exclaim with Burns, that

"A man's a man for a' that."

And furthermore, let the grand saying of Terence ring in our ears:

"Homo sum, nihil humanum a me alienum puto!"

And it will come out, I believe, clearer and clearer that through no "natural selection" in the "struggle for existence," can man by any means be a splendid development of some anterior existence referable back to the monad, thence to the combination of certain elements, and so on backwards *ad infinitum*.

FRANCIS DRAKE.

FOSSIL DEER'S HORN AT CLACTON, SHOWING MARKS OF HUMAN OPERATIONS.

By Rev. O. Fisher, F.G.S., of Elmstead, Colchester.

Dr. Bree, the well-known naturalist and author of "Species not Transmutable," has kindly entrusted to my care a very interesting specimen, bearing with much force upon the question of the antiquity of the human race. It is the base of an antler of the red-deer, showing unmistakeable evidences of human operations upon it. The specimen was dredged up about two months ago off Clacton, in Essex, in the course of dredging for cement-stones. Dr. Bree has a portion of the tusk of a mastodon (?) and some fish-bones and teeth, apparently derived from the red crag, from the same source. The spot is two miles from the shore, and is called "The Wallet."

The horn in question was not shed, but has a portion of the bone of the skull adhering to it. It has been *chopped* away from the skull, showing a clear mark or cut on each side. But this is the least remarkable feature. The most interesting point is that the three branches of the horn have been *sawn* off with perfectly clean cuts perpendicularly to their axes, the polished surfaces of the sections being

[illegible]ERS HORN, with cut marks & chopp[illegible] from CLACTON.

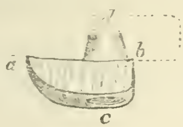
In the Collection of Dr Bree

[illegible] from the Specimen by S. [illegible]

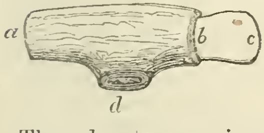
quite uninjured. When it was shown to me, it was suggested that it had been dredged up before, the horns sawn off, and the base thrown back into the sea; but, on applying a lens, I perceived on the sawn surface a portion of the peculiar sandy matrix bound together with oxide of iron, which adheres to all the fossil bones from Clacton.

Of course it would be very difficult to prove a geological antiquity for these saw cuts, because a film of iron left in the process of a recent sawing might, in undergoing oxidation, have cemented some grains of sand together; but the general condition of the surfaces, leads me to think that we have before us the work of an ancient man, and he not very unskilled in the use of his tools. The girth of the base of the bone is nine inches.

When I called upon you on the 10th inst., to leave with you the specimen of the deer's-horn for making an illustration, you were so good as to point out to me an incision and hollowing out of one of the cut faces with the apparent intention of fixing a flint implement of some kind in it, and at the same time you directed my attention to some specimens in the British Museum. As these illustrate the possible use for which Dr. Brees' specimen may have been intended, I will shortly describe them. The specimens are four in number. None of them are so old as the drift. The first is from the Lake dwellings recently discovered at Neufchatel in Switzerland; it is a portion of deer's-horn of a very remarkable form. From *a* to *b* is three and a half inches, and from *c* to *d* three inches. The hole to carry the stone axe at *c* reaches upwards into the portion, *d*, which was intended for insertion into a stout wooden handle, so that the axe would stand at right angles to the handle, and the shoulder, *a b*, would resist the momentum of the blow.



The other three specimens are from superficial deposits of the valley of the Somme. From *a* to *b* is four inches, and from *d* to *e* two and a quarter inches. *b c* is a flint celt rubbed perfectly smooth inserted in a hole at *b*. *d* is a branch of the horn cut off, and the stump pierced with a small hole to carry the handle of the axe.*



The other two specimens are from the same locality, and of a very similar form. The flint celts have fallen out. They appear at present with rude flake-shaped implements inserted into them, but these are evidently not the original ones, and the plaster of Paris into which they are fixed is easily discernible. In all these axes it is

* This specimen is figured at p. 22 in vol. iv. of this magazine.

remarkable that the holes for the handles are very small, as if the handles had been pliable like the hazel-stick handles they use in some districts for stone hammers to crack flints for road mending.

It has occurred to me that the smooth faces of the surfaces in Dr. Brees' specimen may have been cut after having been chopped off, and that they do not *necessarily* imply the use of a saw. They were not *rubbed* down. The marks of cutting are plain, and they are a little hollowed out in the direction of the edge of the instrument with which the cuts were made, as you would almost inevitably hollow the end of a stick if you attempted to cut it flat with a common knife.

I must not omit to mention the kindness with which the curator of the Antiquities department of the Museum supplied the information I required respecting the specimens there.

CORRESPONDENCE.

ON THE DISCOVERY OF MACRAUCHENIA IN BOLIVIA.

Sir,—As you inserted a report of the lecture by Professor Huxley, on which the following remarks are founded, perhaps you will not object to give place to them also; they appeared in the last number of the "Annals of Natural History."

In the February number of the "Quarterly Journal of the Geological Society," a report of a paper appeared, read by Prof. Huxley on November 21, 1860, respecting "a new species of *Macrauchenia* (*M. boliviensis*), obtained by Mr. Forbes from the mines of Corocoro, in Bolivia." In this paper the following note is inserted:—

"As the Guanaco ranges into the highlands, it may not be a too sanguine expectation to hope for the future discovery of remains of the great *Macrauchenia* also in Bolivia" (p. 83).

As this statement, unaccompanied by any reference to the corroborative testimony of other palæontologists, is calculated to leave the reader under the impression that remains of *Macrauchenia patachonica* are yet undiscovered in Bolivia, I must respectfully indicate to those readers of your valuable periodical who are unacquainted with the fact, that Mr. Weddell, writing in Castelnau's "Expédition dans les Parties centrales de l'Amérique du Sud," 4to, Paris, 1855, states, on page 36th of the 7th Partie (Zoologie), and on page 203 of the 6th volume of the "Histoire du Voyage," 8vo, Paris, 1851, that bones of *Macrauchenia* were found at Tarija, in South Bolivia, imbedded in the soil with *Mastodon Humboldtii*, *Scelidotherium*, *Megatherium*, three species of true *Auchenia*, *Equus macrognathus* vel *neogeus*, *Ursus*, &c. He does not specially distinguish them from *M. patachonica*, and figures them under that name on plate 8 of the 7th part. If the remains described by Prof. Huxley should prove to be of a distinct species, the fact would be not merely that "a small and a large species of Auchenoid mammal ranged the mountains and the plains of South America respectively," but that two nearly similar species of *Macrauchenia* co-existed in the highlands of Bolivia during the Post-pleistocene epoch. As Tarija, on the eastern slopes of the Bolivian Andes, is almost beyond the limits of the geographical range of Guanaco, which is by no means such a denizen of the plains as Prof. Huxley would infer, the existence of a fossil Auchenoid mammal (a so-called *hueso de gigante*") at that place is a fact of much more importance than the existence of a similar animal at Corocoro, in the elevated valleys of the Aymará country, at the foot of the enormous Illimani.

As Mr. Forbes, in the memoir preceding Prof. Huxley's, mentions at great length the Salinas, the volcanic origin of common salt, and the physical geography of Peru and Bolivia, I may be permitted to indicate that much valuable information on these subjects is to be found in Mr. W. Bollaert's " Antiquities and Ethnology of South America," 8vo, London, 1860, and in his paper in the " Journal of the Royal Geographical Society," vol. xxi., 1851, with a map. Apparently the researches of both MM. Castelnau and Bollaert have been unknown to Messrs. Forbes and Huxley.

The specific name *boliviensis*, applied by Prof. Huxley to the smaller form, will no doubt be abrogated by succeeding naturalists, as founded on a misconception of the geographical distribution of the genus.

Prof. Huxley, impugning the philosophical laws of " correlation of structure" as defined by Cuvier and Owen, suggests that, upon the Cuvierian method of induction, a palæontologist, reasoning alone from the cervical vertebra of *Macrauchenia*, would have confidently predicted its Cameloid affinities. But when Prof. Huxley founds an argument, put hypothetically into the mouth of an ideal adversary, upon a structure so liable to variation as the perforation by a blood-vessel of a cervical vertebra, it can hardly be accepted as a correct exemplification of the principal which Cuvier has so successfully applied. The non-perforation of a cervical vertebra by an artery is certainly not such a character, subserving an important purpose, and denoting ordinal distinction, as the presence of a marsupial bone in an opossum, with which Prof. Huxley compares it. The analogy which it is attempted to deduce, as adverse to the principles of correlation, therefore totally fails, whilst this high law of comparative anatomy, "*aussi certaine qu'aucune autre en physique ou en morale*," remains unimpaired by the re-discovery of Macrauchenian remains in the Andes.

Your obedient servant,

Judd-street, Brunswick-square, June 24. CHARLES CARTER BLAKE.

GEOLOGICAL EVIDENCES OF THE DELUGE OF NOAH.

DEAR SIR,—Although it is a rule with me to abstain from mixing up biblical and geological questions, believing it to be unwise, and by no means calculated to be of service to either, I am for once induced by the first query of your correspondent S. M., in the last number of the " GEOLOGIST," to depart somewhat from this rule.

The query to which I refer is, "What evidence have we, geological or otherwise, apart from the history of the Bible of the existence of the Deluge ?" Now, waving the question of the universality of the Deluge, I would ask, What geological evidence of this event does the Biblical narrative warrant our expecting ? True, we are told that " All the fountains of the great deep were broken up, and the windows (flood-gates in the margin) were opened ;" but these, I apprehend, are poetical—what if I say hyperbolical—expressions simply intended to convey an idea of the rapid and great rising of the waters.

When Noah sent forth the dove the second time, we learn that " The dove came into him in the evening ; and, lo, in her mouth was an olive-leaf plucked off ; so Noah knew that the waters were abated from off the earth." Now the olive-leaf could only warrant the inference Noah drew from it—and, as the sequel shows correctly—on the supposition that the dove had not found it floating, a waif, on the diluvial waters, but had plucked it from a tree still standing in its place and, indeed, growing. The Deluge, then, was not equal to the uprooting, breaking, or killing an olive tree; *a fortiori*, it was not equal to the production of geological phenomena such as man would be likely to recognize many years afterwards as its effects, and the proofs of its existence.

I am, Sir, yours, &c.,

Lamorna, Torquay, July 3rd, 1861. WM. PENGELLY.

SPIRIT OF GOOD BOOKS.

MR. PRESTWICH'S AND MR. EVANS'S PAPER ON FLINT IMPLEMENTS.

(*Continued from page* 328.)

THIS Boulder clay caps all the hills around and forms a low table-land, through which the valleys are cut. Its very uneven base rests on white and yellow sands and gravel (5). In some places, however, thick beds of ochreous and ferruginous subangular flint-gravel, with subordinate beds of sand, form low hills subtending the main plateau along the valley of the Waveney. This gravel (2) is newer than the Boulder clay against which it usually slopes off, running, in thin patches, up some of the lateral valleys.

"The top of the freshwater deposit of Hoxne reaches within six or eight feet of the summit of the hill, of which it forms an unbroken and uniform part. The adjacent hills are of about the same height, and there is no ground above a few feet higher for some miles around. No existing drainage, nor any possible with this configuration of surface, could have formed these clays and gravel beds, at the relative level they now occupy.

"Since writing the above, I have had the pit and the intermediate ground to the Waveney levelled. The top of the pit proves to be forty-two feet above the adjacent brook, fifty-three feet above the Waveney, and one hundred and twelve feet above the sea. With Sir Edward Kerrison's courteous permission, we had also several trenches dug in the park to trace the extention of the freshwater deposit.* Altogether there have been sixteen trenches and borings made in and around the pit.—(October, 1860.)

"The presence and abundance of perfect shells of *Valvata* and *Bithinia*, and the quantity of vegetable matter render it probable that these beds were accumulated by a slow stream, or a small marshy lake or mere, into which land-shells, the remains of land-animals, and drifted wood were carried down. The materials of this freshwater deposit are mainly such as would be produced and sorted by the slow wearing away of the Boulder clay. The clays and marls and the associated flint-gravels, with the pebbles of chalk, of quartz, and of hard sandstone, are materials just such as the artificial washing of the adjacent Boulder clay now produces in the same field—a pure calcareous clay on the one hand, and a heap of rough gravel and flints, and older rock pebbles, on the other. The level of the Boulder clay in the adjacent field is lower than the

* The results of these operations are embodied in the plans and sections plate x. of Mr. Prestwich's paper.

brick-pit, whilst elsewhere around it rises higher. The irregular patchs of sand and gravel on the top of the whole are not of local origin, but belong, I believe, to the general superficial drift of the district. A portion of the freshwater deposit has suffered denudation,—a denudation evidently of the date of that which formed the small valley running down by Hoxne to the Waveney, and connected with the general valley system of the district.

"This Hoxne section furnishes us with an important clue to the relative age of these several flint-implement bearing deposits. As far as we can now judge it is clearly newer than the Boulder clay, and is probably older than some portion of the superficial sands and gravels. Probably of the same age, and much resembling the Hoxne deposit in many of its details, are the deposits at Mundesley, Copford, Lexden, and others in the South of England. They were all formed before the country had assumed exactly its present form of surface,—before all its variety of hill and dale had been fashioned to their present shape. Even should the exact position of the worked flints at Hoxne prove to be above all the bone-bearing beds, and not in them, still they are contemporaneous with an old condition of surface, and that over the whole is spread a drift concomitant with a modification of that surface, and giving the stamp to some of the present minor features of the country, is in either case a very remarkable fact."

In his general conclusions, Mr. Prestwich states that "The flint-implements occur associated with the remains of land, freshwater, and marine Testacea, of species now living and most of them yet common in the same neighbourhood, and also with the remains of various Mammalia,—a few species now living, but more of extinct forms;" and further, that "the period at which their entombment took place was subsequent to the Boulder clay period, and to that extent post-glacial; and also that it was amongst the latest in geological time,—one apparently immediately anterior to the surface assuming its present form, so far as it regards some of the minor features.

"It is true that no remains of man himself have yet been found—that is still to be desired; but if it be admitted that the flint-implements are his work, the negative point becomes an argument of less value.

"Whilst abstaining from any general hypothesis in explanation of the phenomena, there is, however, one point to which I must refer before concluding, although I cannot, at present, venture beyond a few generalities respecting it. It might be supposed in assigning to man an appearance at such a period, it would of necessity imply his existence during long ages beyond all exact calculation; for we have been apt to place even the latest of our geological changes at a remote, and to us, unknown distance. The reasons on which such a view has been held have been, mainly,—the great lapse of time considered requisite for the dying out of so many species of great mammals,—the circumstance that many of the smaller valleys have been excavated since they lived,—the presumed non-existence of man himself,—and the great extent of the latter and more modern accumulations. But we have in this part of Europe no succession of strata to record a gradual dying out of the species, but much, on the contrary, which points to an abrupt end, and evidence only of relative not of actual time; while the recent valley-deposits, although often indicating considerable age, show rates of growth which, though variable, appear on the whole to have been comparatively rapid. The evidence, in fact, as it at present stands, does not seem to me to necessitate the carrying of man back in past time, so much so as the bringing forward of the extinct animals towards our own time; my own previous opinion, founded on an independent study of the superficial drift or Pleistocene deposits, having likewise been certainly in favour of the latter view. There are numerous phenomena, which I can only consider as evidence of a sudden change, and of a rapid and transitory action and modification of the surface, at a comparatively recent geological period—a period which, if the foregoing facts are truly interpreted, would seem nevertheless to have been marked, before its end, by the presence of Man on a land clothed with a vegetation apparently very similar to that now flourishing in like latitudes, and whose waters were inhabited by Testacea also of forms now living; while on the surface of the land there lived Mammalia, of which some species are yet the associates of man, although accompanied by others, many of them of gigantic size, and of forms now extinct."

Mr. Prestwich's paper contains much more valuable matter, and much more minute detail, than we can afford space to give. It is more fully illustrated with excellent plates, maps, sections, and woodcuts, of more finish and detail than the merely characteristic sketches we have made from them. We have given enough, however, to bring before our readers the important features of his valuable paper. We now pass to that of Mr. Evans, printed in the Archaeologia.

"It has been generally supposed that the last of the great geological changes took place at a period long antecedent to the appearance of man upon the earth, and that the modifications of the earth's surface of which he has been a witness have been—with the exception of those due directly to volcanic agency—but trifling and immaterial.

"The subject of the present paper, the discovery of flint implements wrought by the hand of man, in what are certainly undisturbed beds of gravel, sand, and clay, both on the continent and in this country, tends to show that such an opinion is erroneous; and that in this region of the globe, at least, its surface has undergone far greater vicissitudes since man's creation than has hitherto been imagined. A discovery of this kind must of necessity be of great interest both to the geologist, as affording an approximate date for the formation of these superficial beds of drift, and as exemplifying the changes which the *fauna* of this region has undergone since man appeared among its occupants; and also to the antiquary, as furnishing the earliest relics of the human race with which he can hope to become acquainted—relics of tribes of apparently so remote a period, that—

> Antiquity appears to have begun
> Long after their primeval race was run.

But beyond the limited circle of those peculiarly interested in geology or archæology, this discovery will claim the especial attention of all who, whether on ethnological, philological, or theological grounds, are interested in the great question of the antiquity of man upon the earth.

"The question whether man had or had not coexisted with the extinct pachydermatous and other mammals, whose bones are so frequently found in the more recent geological deposits, had indeed already more than once been brought under the notice of scientific inquirers by the discovery of flint flakes and implements and fragments of rude pottery, in conjunction with the remains of these animals in several ossiferous caverns both in England and on the continent. Among the former may be mentioned Kent's Cavern near Torquay, and among the latter those of Bize, of Pondres, and Souvignargues, and those on the banks of the Meuse, near Liège, explored by Dr. Schmerling, where human bones were also found, apparently washed in at the same time as the bones of the extinct quadrupeds. In some ossiferous caves in the Brazils similar discoveries had also been made by Dr. Lund and M. Claussen, and, from the condition and situation of the human remains, Dr. Lund concluded that they had belonged to an ancient tribe that was coeval with some of the extinct mammalia.

"But it was always felt that there was a degree of uncertainty attaching to the evidence derived from the deposits in caverns, owing to the possibility of the relics of two or more entirely distinct periods becoming intermixed in such localities, either by the action of water or by the operations of the primitive human occupants of the caves, which prevented any judgment being firmly founded upon it.

"At the end of April, 1859, I joined Mr. Prestwich at Abbeville, and with him inspected the collections of M. de Perthes, to whose courtesy and hospitality we were largely endebted, and also visited in his company several of the pits worked for gravel and sand in the neighbourhood of both Abbeville and Amiens, in which the flints in question were asserted to have been found.

"The drift-beds occurring in different localities in the neighbourhood of Abbeville and Amiens, do not appear to have been all deposited at the same time, but to be of at least two distinct ages; the series on the lower level being distinguished by the occurrence within it of the bones and teeth of the *Elephas primigenius*, or Siberian mammoth, and of other extinct animals. These mammaliferous beds of sand, loam, and gravel extend over a considerable tract of country on the slopes of the valley of the Somme, and are worked in several localities for the repair of the roads and for building purposes.

"One of the pits at St. Acheul occupies the site of a Gallo-Roman cemetery, which appears to have continued in use for some centuries: large stone coffins, and the iron cramps of those in wood, are of frequent occurrence, but personal ornaments are rarely met with. Roman coins are found from time to time, some as early as the reign of Claudius, and I purchased from one of the workmen a second-brass coin of Magnentius, with the letters AMB in the exergue, showing that it had been struck at "Ambianvm," the name given in late Roman times to the neighbouring town of Amiens, which by the Gauls was known as "Samarobriva."

"Let us now turn our attention to the flint implements alleged to have been discovered in the drift in company with the remains of what has usually been regarded an older world; and consider, first, how far in material, form, and workmanship they agree with or differ from the stone weapons and implements so commonly found throughout Europe; and then enter upon an examination of the evidence of the circumstances of their finding, and the means at our command for ascertaining their degree of antiquity.

"That they really are implements fashioned by the hand of man, a single glance at a collection of them placed side by side, so as to show the analogy of form of the various specimens, would, I think, be sufficient to convince even the most sceptical. There is a uniformity of shape, a correctness of outline, and a sharpness about the cutting edges and points, which cannot be due to anything but design; so that I need not stay to combat the opinion that might otherwise possibly have arisen that the weapon-like shapes of the flints were due to some natural configuration, or arose from some inherent tendency to a peculiar form of fracture.

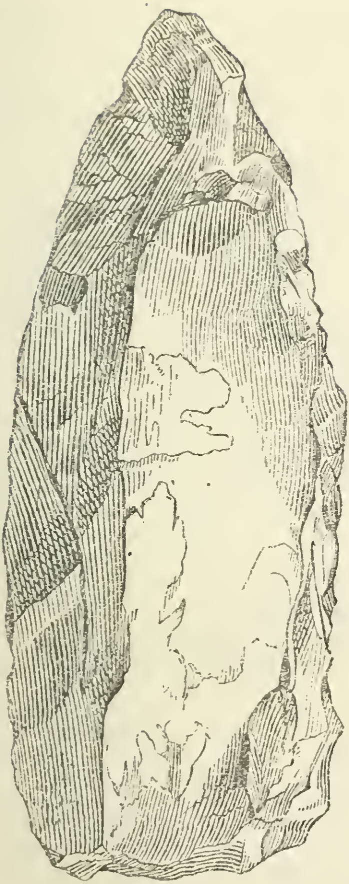
"The material of which they have been formed, flint derived from the chalk, is the same as has been employed for the manufacture of cutting implements by uncivilized man in all ages, in countries where flint is to be found. Its hardness, and the readiness with which it may be fractured so as to present a cutting edge, have made it to be much in request among savage tribes for this purpose; and in some instances flint appears to have been brought from a distance when not found upon the spot. There is, therefore, nothing to distinguish these implements from the drift, as far as material is concerned, from those which have been called celts, except, perhaps, that the flints have not been selected with such care, nor are they so free from flaws as those from which the ordinary flint weapons of the Stone period were fashioned. There is, however, this to be remarked, that the aboriginal tribes of the Stone period made use of other stones beside flint, such as greenstone, syenite, porphyry, clay-slate, jade, &c., whereas the weapons from the drift are, as far as has hitherto been ascertained, exclusively of flint. As to form, the implements from the drift may, for convenience sake be classed under three heads, though there is so much variety among them that the classes, especially the second and third, may be said to blend or run one into the other. The classification I propose is as follows:—

"1. Flint flakes, apparently intended for arrow-heads or knives.
"2. Pointed weapons, some probably lance- or spear-heads.
"3. Oval or almond-shaped implements, presenting a cutting edge all round.

"In M. de Perthes' museum, and in the engravings of his "Antiquités Celtiques et Antédiluviennes," many other forms of what he considers to be implements may be seen, but upon them the traces of the hand of man are to my mind less certain in character. The flints resembling in form various animals, birds, and other objects, must, I think, be regarded as the effect of accidental concretion and of the peculiar colouring and fracture of flint, rather than as designedly fashioned. This is, however, a question into which I need not enter, as it in no way affects that now before us. Suffice it that there exists an abundance of implements found in the drift which are evidently the work of the hand of man, and that their formation cannot possibly be regarded as the effect of accident or the result of natural causes. When once their degree of antiquity has been satisfactorily proved, it will be a matter for further investigation whether there are not other traces to be found of the race of men who fashioned these implements, besides the implements themselves.

"These objects I must now consider in the order proposed, with reference to their analogies and differences in form, when compared with those of what, for convenience sake, I will call the Stone period.

"There is a considerable resemblance between the flint flakes apparently intended for arrow-heads and knives (the first of the classes into which I have divided the implements), and those which when found in this country, or on the continent, are regarded as belonging to a period but slightly prehistoric. The fact is, that wherever flint is used as a material from which implements are fashioned, many of the flakes or splinters arising from the chipping of the flint, are certain to present sharp points or cutting edges, which by a race of men living principally by the chase are equally certain to be regarded as fitting points for their darts or arrows, or as useful for cutting purposes: they are so readily formed, and so well adapted for such uses without any further fashioning, that they have been employed in all ages just as struck from off the flint. The very simplicity of their form will, however, prevent those fabricated at the earliest period from being distinguishable from those made at the present day, provided no change has taken place in the surface of the flint by long exposure to some chemical influence. As also they are produced most frequently by a single blow, it is at all times difficult, among a mass of flints, to distinguish those flakes formed accidentally by natural causes, from those which have been made by the hand of man; an experienced eye will indeed arrive at an approximately correct judgment, but from the causes I have mentioned, mere flakes of flint, however analogous to what we know to have been made by human art, can never be accepted as conclusive evidence of the work of man, unless found in sufficient quantities, or under such circumstances, as to prove design in their formation, by their number or position. Flint flakes apparently intended for arrow-heads and knives have been found in the sands and gravel near Abbeville, and some were dug out of the sand at Menchecourt, in the presence of Mr. Prestwich, quite at the bottom of the beds of sand. One from this locality is here engraved.



Flint from Menchecourt, Abbeville (full size).

"Occasionally they are of larger size, and have been chipped into shape at the point, so as nearly to resemble the implements of the next class.

"An argument may be derived in favour of the majority of these arrow-head-shaped flakes having been designedly made, not only from their similarity in form one to another, but also because the existence of more carefully fashioned flint implements almost necessarily implies the formation and use of these simpler weapons by the same race of men who were skilful enough to chip out the more difficult forms. But though probably the work of man, and though closely resembling the flakes of flint which have been considered as affording evidence of man's existence when found in ossiferous caverns, this class of implements is not of much importance in the present branch of our inquiry; because, granting them to be of human work, and not the result of accident, there is little by which to distinguish them from similar implements of more recent date.

"The case is different with the implements of the second class, those analogous in form to spear- or lance-heads. Of these there are two varieties, the one with a rounded cutting point, its general outline presenting a sort of parabolic curve (Pl. 1, No. 1); the other acutely pointed, with the sides curved slightly inwards (Pl. 1, No. 2). These have received from the workmen of St. Acheul the name of *langues de chat*, from their fancied resemblance in form to a cat's tongue. The sides of both kinds are brought to an edge by chipping, but are not so sharp as the point, and altogether these weapons seem better adapted for piercing than for cutting. In length they vary from about four inches to eight or even nine inches. Both shapes are generally more convex on one side than the other, the convexity in some cases almost amounting to a ridge; they are usually truncated at the base, and not unfrequently at that end show a portion of the original surface of the flint; in some specimens the butt-end is left very thick, as if to add impetus to any blow given with the implement. The remarkable feature about them is, their being adapted only to cut or pierce at the pointed end; whereas in the ordinary form of stone hatchet or celt, the cutting edge is almost without exception at the broad end, while the more pointed end seems intended for insertion into the handle or socket, and the sides are generally rounded or flat, and not sharp.

"These spear-shaped weapons from the drift are, on the contrary, not at all adapted for insertion into a socket, but are better calculated to be tied to a shaft or handle, with a stop or bracket behind their truncated end. Many of them, indeed, seem to have been intended for use without any handle at all, the rounded end of the flints from which they were formed having been left unchipped, and presenting a sort of natural handle. It is nearly useless to speculate on the purposes to which they were applied; but, attached to poles, they would prove formidable weapons for encounter with man or the larger animals, either in close conflict or thrown from a distance as darts. It has been suggested by M. de Perthes, that some of them may have been used merely as wedges for splitting wood; or, again, they may have been employed in grubbing for esculent roots, or tilling the ground, assuming that the race who formed them was sufficiently advanced in civilization. This much I think may be said of them with certainty, that they are not analogous in form with any of the ordinary implements of the so-called Stone period.

"The same remark holds good with regard to the third class into which I have divided these implements, viz., those with a cutting edge all round (pl. ii., No. 3). In general contour they are usually oval, with one end more sharply curved than the other, and occasionally coming to a sharp point, but there is a considerable variety in their form, arising probably from defects in the flints from which they were shaped; the ruling idea is, however, that of the oval more or less pointed.

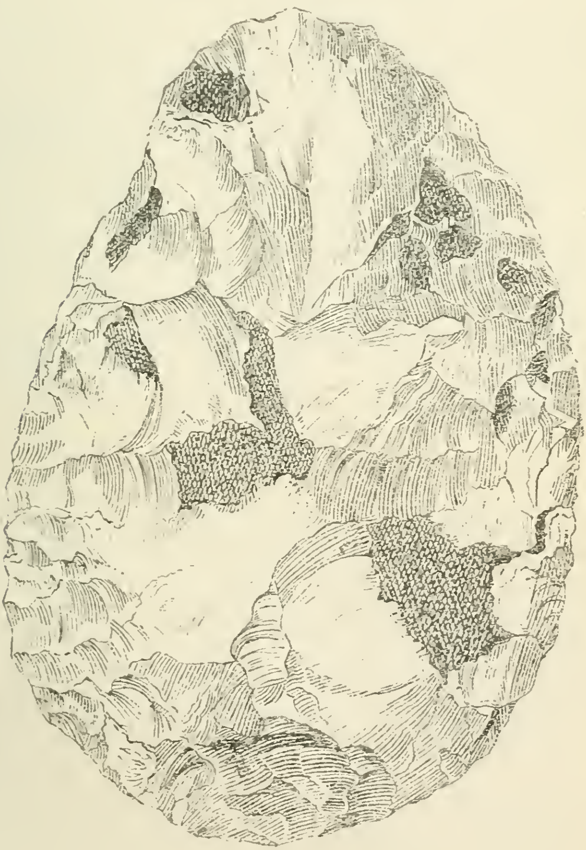
"They are generally almost equally convex on the two sides, and at length vary from two to eight or nine inches, though for the most part only about four or five inches long.

"It is to be remarked that among the implements discovered in the cavern called Kent's Hole, near Torquay, were some identical in form with those of the oval type from Abbeville.

"As before observed, in character they do not resemble any of the ordinary stone implements with which I am acquainted, though I believe some few of these also present a cutting edge all round, but at the same time are much thinner, and more triangular than oval or almond-shaped in their form.

"As to the use which this class of flint-implements from the drift was originally intended to fulfil, it is hard to speculate. The workmen who find them usually consider them to have been sling-stones, and such some of the smaller sizes may possibly have been, whether propelled from an ordinary sling or from the end of a cleft stick; many, however, seem to be too large for such a purpose, and were more probably intended for axes cutting at either end, with the handle securely bound round the middle of the stone, and if so there would be a reason why it might be desirable to have one end more pointed than the other, so that one instrument could be applied to two kinds of work. M. de Perthes has suggested, that they might also have been mounted as hatchets by insertion in a socket scooped out in a handle. But all this is conjecture. In point of workmanship, I think it will be perceived that the weapons or implements now under consideration differ considerably from those of the so-called Stone-period: of these latter, by far the greater number (with the exception of the arrow-heads) are more or less ground, and even polished; some with the utmost care all over, but nearly all ground sufficiently to ensure a clean cutting edge. The The implements from the drift are, on the contrary, so far as has been hitherto observed never ground, but their edges left in the rough state in which they have been chipped from the flint.

"The manner in which they have been fashioned appears to have been by blows from a rounded pebble mounted as a hammer, administered directly upon the edge of the implements, so as to strike off flakes on either side. At all events I have by this means reproduced some of the forms in flint, and the edges of the implement thus made present precisely the same character of fracture as those from the drift.



Oval-shaped flint implement from the valley of the Somme.

"In instances where (either from having been left accidently unfinished, or from never having been intended to be ground) the weapons of the Stone period have remained in their rough-hewn state, it will be observed that, with very few exceptions, they are chipped out with a greater nicety and accuracy, and with a nearer approach to an even surface, than those from the drift, and, rude as they may appear, point to a higher degree of civilization than that of the race of men by whom these primitive weapons or implements were formed.

"I think that enough has been said to make it apparent to all who have made a study of the stone implements usually found (those of the so-called Stone period) that the spear-heads and sling stones, or axes, or by whatever name they are to be called, which are now brought under their notice, have but little in common with the types already known; they will therefore be prepared to receive with less distrust the evidence that they are found under circumstances which show that, in all probability, the race of men who fashioned them must have passed away long before this portion of the earth was occupied by the primitive tribes by whom the more polished forms of stone weapons were fabricated, in what we have hitherto regarded as remote antiquity.

"In the cultivated soil and made ground above, and at much less depth from the surface, ground and polished instruments, evidently belonging to the so-called Stone period, have indeed been found; but this again only tends to prove that the shaped flints discovered at much greater depth belonged to some other race of men; and inasmuch as they certainly are not the work of a subsequent people, we have here again a testimony that they must be referred to some antecedent race, which had perished perhaps ages before the Celtic occupation of the country. The similarity in form between the flint-implements from the drift, and those found in the cave-deposits that I have previously mentioned, is also a circumstance well worthy of observation."

Mr. Evans then goes over the geological evidence furnished by Mr. Prestwich, and details the finding of one implement, *in situ*, by Mr. Flower, which ground it would be superfluous for us to go over again, as the chief part of Mr. Evans' geological data is derived directly from Mr. Prestwich.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—June 19, 1861.

1. "On the Lines of Deepest Water around the British Isles." By the Rev. R. Everest, F.G.S.

By drawing on a chart a line traversing the deepest soundings along the English Channel and the Eastern Coast of England and Scotland, continuing it along the hundred-fathom-line on the Atlantic side of Scotland and Ireland, and connecting with it the line of deepest soundings along St. George's Channel, an unequal-sided hexagonal figure is described around the British Isles, and a pentagonal figure around Ireland. A hexagonal polygon may be similarly defined around the Isle of Arran. These lines were described in detail by the author, who pointed out that they limited areas similar to the polygonal form that stony or earthy bodies take in shrinking, either in the process of cooling or in drying. The relations of the hundred-fathom-line to the promontories, the inlets, and general contour of the coast were dwelt upon; and the bearings that certain lines drawn across the British Isles from the projecting angles of the polygon appear to have on the strike and other conditions of the strata were described. After some remarks on the probable effect that shrinkage of the earth's crust must have on the ejection of molten rock, the author observed that in his opinion, the action of shrinking is the only one we know of that will afford any solution of the phenomena treated of in this paper, namely, long lines of depression accompanied by long lines of elevation, often, as in the case of the British Isles, Spain and Portugal, and elsewhere, belonging to parts of huge polygons broken up into small ones, as if the surface of the earth had once formed part of a basaltic causeway.

Several charts, plans, and drawings were provided by the author in illustration of the paper.

2. "On the Ludlow Bone-bed and its Crustacean Remains." By J. Harley, M.B. Communicated by Prof. T. H. Huxley, Sec. G.S.

Of the two bone-beds occurring near Ludlow, the lower one (seen in Ludford-lane and on the north-east slopes of Whitecliff) is that which has supplied the author with the materials for this paper. Besides spines, teeth, and shagreen-like remains of fish, the author finds in the Ludlow bone-bed three kinds of minute organisms: 1st, conical bodies, the same as the "Conodonts" of Pander; 2ndly, bodies somewhat like the crown of a molar tooth; 3rdly, oblong plates. All these bodies possess the same chemical composition and microscopical structure, which is decidedly *Crustacean*. With *Pterygotus* they do not appear to have any relationship, unless some are the stomach-teeth; nor do they show any alliance with Trilobites; but with *Ceratiocaris* they have a great resemblance as to structural characters, and some of them were probably the minute secondary spines of the tail of that Phyllopod. The plate-like forms might have belonged to Squilloid or Limuloid Crustaceans. To facilitate the recognition of these bodies Mr. Harley places them all in one provisional genus with the name of *Astacoderma*. A letter from Dr. Volborth to the author was also read in confirmation of Mr. Harley's opinion that these bodies are identical with Dr. Pander's "Conodonts." Numerous original drawings illustrated the paper.

3. "On the Old Red Sandstone of Forfarshire." By James Powrie, Esq., F.G.S.

The author described the series of stratified rocks belonging to the Old Red Sandstone, upwards of three thousand feet in thickness, stretching southward from the Grampians to the coast of Fifeshire. 1st. Dark red grits (with cornstones and flagstones) equivalent to the English "tilestones." 2ndly. Thick conglomerates and the Arbroath paving-flags. *Pterygotus anglicus*, *Stylonurus*, *Parka decipiens*, *Cephalaspis*, *Diplacanthus gracilis*, and other fossils belong to this part of the series. 3rdly. Thick-bedded red sandstone (with cornstone) *Cephalaspis* and *Pteraspis*. 4thly. Soft deep-red sandstones. 5thly. Spotted marls and shales: these beds are the uppermost, and may be the equivalents of the Holoptychian beds of Clashbinnie. The author showed that between the Grampians and the trappean hills of Bunnichen and Bunbarrow the series forms a great syncline; and between these hills and the sea the older beds are twice again brought to the surface; and he believes that the marls and sandstones at Whiteness are not unconformable, as Sir C. Lyell has represented them in his published section.

4. The Secretary gave a brief account of the discovery of an exposure of sandstone strata with two bands of clay full of calcareous nodules containing plentiful remains of *Coccosteus*, *Glyptolepis*, and other fishes belonging to the Old Red Sandstone, in a burn about two and a half miles from the Manse at Edderton, Ross-shire, on the south side of Durnoch Firth. This information was contained in a letter from the Rev. J. M. Joass, of Edderton, communicated by Sir R. I. Murchison, V.P.G.S.

5. "On the Outburst of a Volcano near Edd, on the African coast of the Red Sea." By Capt. R. N. Playfair, R.N. Communicated by Sir R. I. Murchison, V.P.G.S.

At Edd, lat. 13 deg. 57 min. north, long. 41 deg. 4 min. east, about half-way between Massouah and the Straits of Bab-el-Mandel, earthquake-shocks occurred on the night of the 7th of May, or the morning of the 8th, during about an hour. At sunrise fine dust fell, at first white, afterwards red; the day was pitch-dark; and the dust was nearly kneedeep. On the 9th the fall of dust abated; and at night fire and smoke were seen issuing from Jebel Dubbel, a mountain about a day's journey inland, and sounds like the firing of cannon were heard. At Perim these sounds were heard at about two A.M. on the 8th, and at long intervals up to the 10th or 11th. The dust was also met with at sea; and along the entire coast of Yemen the dust fell for several days. Several shocks were felt on the 8th at Mokha and Hodaida.

6. "Notice on the occurrence of an earthquake on the 20th of March, 1861, in Mendoza, Argentine Confederation, South America." By C. Murray, Esq. Communicated by the President.

At about a quarter to nine o'clock, the first shock, preceded by a thunder-clap destroyed the city of Mendoza, killing (it is said) two-thirds of its sixteen thousand inhabitants. Altogether there were eighty-five shocks in ten days. The land-wave appears to have come from the south-east. Several towns south-east of Buenos Ayres felt slight shocks. No earthquake took place at Chile; but travellers crossing the Upsallata Pass of the Cordilleras met with a shower of ashes; the pass was obstructed by broken rocks, and chasms opened on all sides. At Buenos Ayres, three hundred and twenty-three leagues from Mendoza, and elsewhere, it was observed in watch-makers' shops that the pendulums moving north and south were accelerated; those moving east and west were not affected.

7. "On the increase of Land on the Coromandel Coast." By J. W. Dykes, Esq. In a Letter to Sir C. Lyell, F.G.S.

In the districts of the Kistna and Godavery, the land presents a parallel series of ridges and hollows near the coast, not in relation to the rivers but to the coast-line. These may now be formed by sedimentary deposits similar to what are now taking place on the Coromandel coast. By the strong currents alternately running north and south, according to the monsoons, lines of sediment parallel with the coast are formed; and by the occasional interference of winds and tides dams are thrown across the hollows, and the latter soon become filled up. These parallel bands of coast-land become, in time, upheaved and more or less affected by atmospheric agencies.

NOTES AND QUERIES.

Pteraspis Remains at Cradley.—Dear Sir,—Since the appearance of Mr. Roberts' interesting paper in "The Geologist," on "The Geographical Distribution of Pteraspis," &c., I have visited one of the quarries mentioned by him, namely, at Cradley. I cannot coincide with Mr. Roberts, when he says that "from Cradley only fragments of scutes may be obtained," and that "good scutes are of rare occurrence." On the contrary it is my opinion, and that of a celebrated geologist who is well acquainted with all the Herefordshire fish-quarries, and who accompanied me to this spot, that this quarry, if not *the* most, is at least one of the most productive quarries of Herefordshire. The number of Pteraspis there is something astonishing. Every block one turns contains three or four fine specimens. Not only can "good scutes" be obtained, but specimens with both the rostrum and lateral cornua attached are not uncommon. Mr. Roberts' remarks also led me to infer that the specimens he had obtained or had seen from Cradley were either *P. Lloydii* or *P. Lewisii*. Now I obtained some twenty specimens or more, and all these were *P. rostratus*; in fact I did not meet with one specimen of *P. Lewisii* or *P. Lloydii*. I would further remark that with regard to Cradley, Cephalaspis is by no means so abundant as its cousin, Pteraspis, though I did obtain three or four tolerable heads. Let me also inform those who are about to visit this quarry (and I hope many are), that if they are not content with the proceeds of their own labour they may obtain specimens both of Cephalaspis and Pteraspis from one, Jacob Gill, a respectable Scotchman residing on the spot, and who has obtained many fine speeimens. I hope now that I have shown that Cradley is a little more worthy of a visit than Mr. Roberts makes out. Its situation, too, is so convenient, that many ought to visit it from Malvern, the distance between the two places being barely seven miles.—I remain, yours, &c., E. R. LANKESTER.

GEOLOGY OF HUDDERSFIELD.—In reply to your question of a "Young Geologist" in the July number, I may mention that along the Yorkshire coast from Spurn Point to Hartlepool the strata belongs to the Secondary Division, except a small portion called the Bridlington crag, discovered by the late Mr. Wilkinson, of Bridlington Quay. The strata above alluded to are overlaid by Drift; the greater proportion of which consists of a purple clay, mixed with fragments of "almost every kind of rock," both water-worn and sharp and angular, and varying from pebbles to boulders of large size and weight; along with these are sometimes found bones of Mastodon, Elephant, Irish Elk, &c., and *here and there implements of flint*.

At Spurn the beach is low and shingly. Kilnsea crag and a new cave are great attractions between Dimlington Hill and Holmpton, where is a freshwater deposit; and the like occurs at Witheningsea, Sandley Mere and Grinston Garth. Near Hornsey there is a submerged forest. At Skipsey, Barmston, and Auburn, various bones, of extinct animals are met with, as also are freshwater shells in abundance. When the tourist arrives at Bridlington he can examine the chalk in the various quarries at that place, and freshwater shells are to be found in the cliff on both sides of Bridlington Harbour.

The Bridlington crag is met with near the north side of the north pier; but this deposit can seldom be worked, owing to its being covered by sand and gravel thrown up by the sea. Some good specimens of the fossils are in the museum of Arthur Strickland Esq., at Bridlington Quay. Two miles north-east of Bridlington Quay is Sowerby, where, in the chalk, a little below high-water-mark, the collector will be rewarded with a fine series of fossil sponges, &c. This locality must be visited from Bridlington, that being the safest road to Sowerby Cliffs. The next point of attraction is the great cave at Flamborough, called "Robin Lythes Hole," and three hundred feet long by and ninety feet high; besides which, there are to be seen large pillars of chalk, which once formed the entrance to other caves of even larger dimensions. From Flambro' the geologist must retrace his steps to Marton station, and proceeding to Speeton (four miles), will there find the far-famed Speeton Clay, sometimes considered as equivalent to the Gault, very rich in most beautiful fossils. Skirting the "beck," will be found red clay and chalk overlying a bed of greenish grey chalk; the red chalk rising from the sea shore at about three miles from Speeton, &c. No more can here be stated about this singular stratum of Red Chalk, but much more may be seen and found by a careful examination than has hitherto been reported in the Rev. Mr. Wiltshire's account. Yet that gentleman's paper will be a guide. The Speeton Clay is succeeded by the first member of Middle Oolite, the Coral Rag, and Calcareous Grit, which rocks form that remarkable and dangerous rock called Filey Brig. From this point northward the strata continue to rise above the level of the sea, and are succeeded by thick beds of Oxford clay, resting on hard, sandy, and ferruginous beds called Kelloway rock, forming the bold romantic cliffs on which stands Scarborough castle. In conclusion we state that the young gentlemen from Huddersfield may, when they arrive at Whitby, for one shilling and sixpence, purchase a book called "The Fossils of the Yorkshire Lias Described from Nature," which book contains a short outline of the geology of the Yorkshire coast, illustrated with sections, and intended as a guide for strangers. There is also a map, by Mr. Simpson, price sixpence, to may be had at Silvestor Reeds', Whitby, or in London of Whittaker and Co., Ave Maria Lane.—I am, Sir, yours, &c., E. TINDALL, Bridlington.

OLD RED CORNSTONE.—June 5th.—Received a visit from Messrs. Powrie and Page, whom I accompanied to the Park-kill Cornstone, and red and grey sandstones. The cornstone is overlaid by a coarse yellow-coloured sandstone, with intermediate stripes of red and blue marls, and strikingly, as remarked by Mr. Powrie, resembles the Dura Den beds, in confirmation of my own views. The true *Holoptychian Red*, like Clashbinnie, indicates and abounds in the scales of this typical fish. The *Parka decipiens* tilestone, the first discovered habitat of this fossil, was next examined; where amongst the debris I succeeded in finding a beautiful specimen of *Pterygotus anglicus*, the first of the kind ever detected in this portion of the deposit. The Balruddery and Tealing beds constitute the extension of the formation on the opposite slopes of the Tay.

June 19th.—Visited Mr. Powrie's hospitable mansion, and was truly delighted with his rich collection of the grey *sandstone* fossils. All the quarries around, in a circumference of thirty miles, were examined during my stay, and many interesting specimens obtained, especially from Farnell, so rich in Acanthodus, Climatius, Diplocanthus, &c. Two new and undescribed fossils enrich Mr. Powrie's collection, obtained lately in the quarries of Turim Hill, and one of them with its long tapering tail and caudal fin intermediate to, but strikingly resembling the *Pteraspis* and *Cephalaspis* of the same rock.

July 6th.—Had an interesting and successful day at Dron, in Strathearn, and about nine miles to the westward of Park-hill. The tilestone deposit here dips under, and is also interposed among the traps of the Ochil range. Thin marly beds of a bluish and whitish colour, of very loose texture, are mixed up with hard laminated beds of tilestone, and there is one thick bed of half-indurated clay of twenty feet nearly in thickness. I have not observed this mud accumulation in any other locality of the grey sandstone series, and which indicates perhaps peculiar littoral conditions in the estuary or sea in which it was deposited. Shells in the greatest abundance are embedded in the mud; many of them are very minute and microscopic, others are quite cognizable by the eye, and some are fully a quarter of an inch in length. I regarded them at first as crustacea, but am now convinced they are true shells, probably of the genus *Cypricardia*, or some allied form. The importance of this discovery in our Scottish Devonian system is great, as the first of the conchifera found anywhere in the Old Red north of the Tweed, to explore it fully will be an object of interest. Mr. H. H. Howel, of the Geological Staff of Surveyors, accompanied me on the occasion, and concurred in the views expressed above. —From Dr. Anderson's (Newburgh) *Notulæ Geologicæ*.

THE GEOLOGIST.

SEPTEMBER, 1861.

THE TORBANE HILL MINERAL.

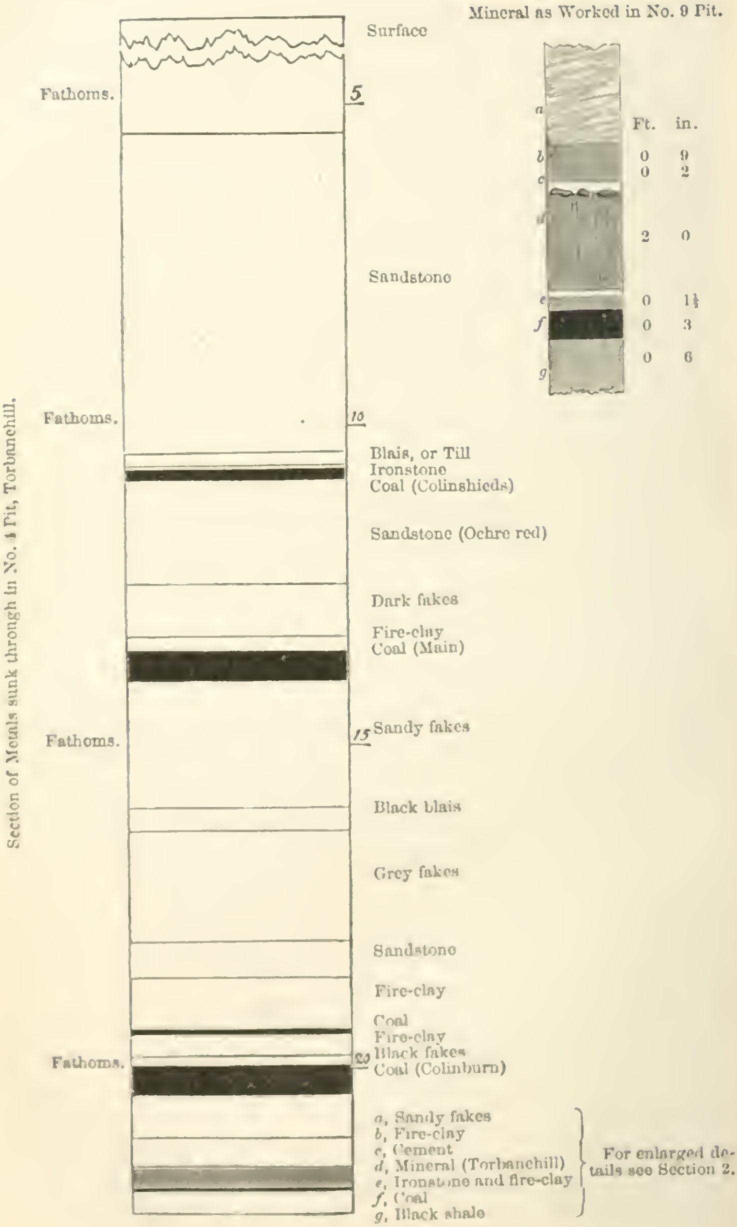
By the Editor.

"Not many years ago," Mr. Salter tells us in his admirable "Lecture on Coal," printed in this volume, "the 'bigwigs' in England were assembled in conclave, and the *élite* of science was called before them" to determine what certain "lumps of a blackish brown substance" were. Was it carbon? Was it shale? Was it cannel? Was it COAL? Now it was on Friday, the 29th July, 1853, that these "bigwigs" were assembled at Edinburgh to give evidence or opinion in the great trial of Gillespie against Russell. The issues put to the jury were, "Whether the defenders are tenants of certain minerals in the lands of Torbane Hill belonging to the pursuers under a missive of agreement? and whether in the course of the period between the term of Candlemas 1850 and the month of May 1852 the defenders wrought and put out from the same lands of Torbane Hill a valuable mineral substance not let to them by the said missive, to the loss, injury, and damage of the pursuers?" and the damages were laid at ten thousand pounds.

This, in simple language, amounted to this: Gillespie had let to the Russells certain lands, with the right to dig *coals;* but the Russells, after they got their lease, extracted *another substance* preferable to coal, for the distillation of paraffin. Mr. Gillespie considered naturally enough that having let the land with the right to dig for coals, the extracting of another mineral for the purpose of making a mineral oil was the taking away of a property belonging to him; while, on the other hand, the Russells, knowing the value of the substance, and the large revenue it was producing, claimed a right to it as being a kind of *coal*. Thus ten thousand pounds and a great revenue rested on the answer to the simple question, WHAT IS COAL? This was the question the "bigwigs" were called upon to answer, and on the whole a pretty mess they made of the attempt. It may seem an easy question to answer, and it may seem an easy thing to call things by their right names. We know, however, it is a very easy thing to call things by wrong names, and so many things have been called *coal* wrongly, that it is not surprising that the "bigwigs" were at sixes and sevens in their replies, and that the jury founded their verdict on a reason totally irrelevant to the case. As the "bigwigs" could not agree as to what coal was, the jurymen went on the broad principle that everything black that would burn was coal, and decided that as the Torbane hill substance was black, and had been sold in the market as Cannel coal, that therefore it must be coal. They found for the defendants accordingly. But the Russels and the Gillespies could not agree even after this lucid decision, the one calling it coal, the other persisting that it was not, and so, after several years, they concurred at last on one point—the only one, we believe, they ever have concurred in—that thenceforth it should be called "THE TORBANE-HILL MINERAL."

Our friend Mr. Salter seems to call it coal still. We do not. And if any of our readers feeling an interest in the question will glance over Mr. Salter's able Lecture on Coal, they will learn, if they did not know it before, How COAL was made. They will see that the old forests grew rank and luxuriant, that the swamps and great shallow estuaries of the carboniferous lands were densely filled with gigantic marshy plants and trees, and that it was from the fallen leaves commingled with broken and uprooted stems—in short, from the accumulated decay of a *living* vegetation that the *coal*-beds were formed. Those masses of vegetable matter which we call *coal* have always under them a bed of under-clay—the ancient subsoil on which they grew; always over them an over-clay or roof, or a stratum of sand or sandstone—some kind of stratum or other to show they have been *covered in*. If we bear in mind Mr. Salter's teachings of their origin, we see at once how necessarily these conditions must be associated with true coal-beds. Now the accompanying section will show that while every bed of coal has an under- and an over-stratum, the Torbane hill mineral has neither. No subsoil for the vegetation that formed it to grow in; no roof of shale or sand to cover in any mass of decaying leaves and tree-stems.

We well remember the question being discussed at the Geological Society, and the witty reply of poor Edward Forbes, then president, when asked What in his opinion was *coal?* "That is a question for my Lord *Coke* to answer," was far nearer the truth than most people at that moment supposed. In the ash—coke or cinder—of *coal* there are traces of vegetable structure—the proofs of its origin. In the residue of bituminous shales and petroleums after burning there is no vegetable structure to be seen—a proof that the origin and constitution is not the same. In geology at least the proof of everything is in itself, and had coal and all other bituminous subtances a common origin, they would all give the same results. It is interesting, then, to consider whether there are not beds of other mineral bituminous substances than coal, the history of which may be not only entertaining but instructive. For the question naturally arises, If the Torbanehill mineral is not *coal*, what is it? Anthracite is fossil *coke*. It is not coal because it is often *called* Welsh "coal," any more than coke from the coke-oven is coal. It was *coal* once, but it has lost its gas, and is not coal *now*. The Torbane Hill mineral is *not* anthracite, neither is it culm nor lignite. It may be a shale (we do not even think it is in the proper sense of that word) but *shale*, however bituminous it may be, is not *coal*. Shale is a bed of laminated clay, and a bed of *clay* is not a deposit of *vegetable matter*. Kimmeridge shale, highly bituminous as it is, is not *coal*. Neither can any shale, however *impregnated* with bitumen, be coal. Are the Caithness flags *coal?* "Of course not." And yet they are so highly impregnated with bitumen that they are used for distillation in the same way as the Torbane Hill mineral. Some geologists say the bitumen in the Caithness flags is derived from fossil fish! True it


Mineral as Worked in No. 9 Pit.
a
b
c
d
e
f
g
Ft. in.
0 9
0 2
2 0
0 1½
0 3
0 6
Section of Metals sunk through in No. 4 Pit, Torbanehill.
Fathoms.
5
Fathoms.
10
Fathoms.
15
Fathoms.
20
Surface
Sandstone
Blais, or Till
Ironstone
Coal (Colinshieds)
Sandstone (Ochre red)
Dark fakes
Fire-clay
Coal (Main)
Sandy fakes
Black blais
Grey fakes
Sandstone
Fire-clay
Coal
Fire-clay
Black fakes
Coal (Colinburn)
a, Sandy fakes
b, Fire-clay
c, Cement
d, Mineral (Torbanehill)
e, Ironstone and fire-clay
f, Coal
g, Black shale
For enlarged details see Section 2.

is the substance of the Caithness fish in the Caithness flags, as black and shining it lies on the surface of the split stone, *is* bitumen. But may not these fossils be bituminous casts of the moulds left in the flagstones by the fossil fish after their decomposition? In limestones is not the substance of the fossil fish carbonate of lime; in sandstone is it not silex—flint. And were flint and carbonate of lime the constituents of the bones of those fish when they lived and swam in the ancient seas?

Were the bones of the living fish of the Caithness-flag period formed of bitumen? If so, what a singular fact is revealed to us—"that in the ancient geological periods the fish formed their osseous skeletons, and the scales of their bodies sometimes of bitumen, sometimes of carbonate of lime, sometimes of flint, and perhaps occasionally of other mineral substances, as they appear to have used *any* material which came to hand with utter indifference, while modern fish, on the contrary, have become excessively fastidious, and make their bones *only* of phosphate of lime."

The Torbane Hill mineral is certainly not Caithness flagstone, and if it be a *shale* it is certainly not coal. Neither is it "Cannel-coal;" and, if it were, we might question that term. *Is* Cannel "coal" *coal?*

"Cannel-coal" means candle-coal, and was so called because the miners cut the substance into strips, and used them as candles in their works. It is, however, very different in structure, appearance and fracture from common coal, and from which it is also distinguished by the products of its distillation.

There are large cannel *oil*-works at Kannaha, in Virginia. There are cannel *oil*-works in England, in France and many other places. But this use which "cannel" coal is put to is very different from any of the general uses of *coal*. It is more in accordance with the use of bituminous shales, petroleums, Rangoon tar, and other substances which nobody dreams of calling coal.

But to return to the Torbane Hill mineral. *It* does not look like *coal;* does not burn like *coal;* is not bedded in the earth like *coal;* never was *made* like *coal*. And, assuredly, it is not COAL.

If we wanted further aid than Geology to show the distinction between them we could call in the chemist, who would tell us that coal naptha consists of hydro-carbons, of the benzol class and the paraffin class: the greatest proportion being of the former, which has been extensively used for aniline and other dyes. He would tell us, too, that for a long time the paraffin series was too difficult to extract in any quantity, and was, therefore, suffered to remain in the pitch and tar; that subsequently, however, an Edinburgh chemist stated that he had found a means of obtaining large quantities by the distillation of coal at low temperatures, but that when his method was tried commercially in Scotland it was found that the only mineral which could be used profitably by his process was the Torbane Hill mineral! Hence there was an additional reason for the Russells attempting at the great trial to prove that substance to be *coal*, because it was the only substance commercially usable in the patented process, for which ordinary *coal* was wholly unfit. If we inquire further as to the products resulting from distillation, we find that coal gives off at low temperatures chiefly benzol oils, with a small proportion of paraffin, whilst from the Torbane Hill mineral there are three series of hydro-carbons, the benzol, the paraffin, and alcohol, of which the proportions are large of paraffin and alcohol, but small of benzol. Indeed the two latter are the chief constituents in the products of all the similar minerals to the Torbane Hill such as the Rangoon tar, the Trinidad Lake pitch, the Pensylvanian well-oils, and native petroleum and bitumen, while, as we have said, benzol products are characteristic of coal.

As the Torbane Hill mineral is not COAL; as it is *probably* not bituminous shale even, it must have a history of its own, and would it not be an interesting inquiry for geologists to make it out to be a deposit of the hardened bitumen of a great pitch-lake like the great pitch lake of Trinidad?

Geologists have never compared the phenomena of such districts as that of Trinidad, the Rangoon tars, or the oil-well region of Pensylvania, in their bearings on the origin of various bituminous shales, flagstones, asphaltes and other bituminous substances certainly *not* COALS, and, whenever the inquiry is gone into, many extraordinary revelations will be made in geological physical geography, and of the operations of nature in her secret and deep-seated laboratory.

CORRESPONDENCE.

FISH REMAINS.

Sir,—In the last number of the "Geologist," some observations were added to your interesting pages by Mr. E. R. Lankester, on the Pteraspis remains at Cradley; he would lead geologists to believe that perfect plates of this fish are found there as plentifully as blackberries in the hedgerows. To use the words of your correspondent, "three or four fine specimens in every block that one turns." This is a little too strong; and differs totally from our experience of the spot. The proper clue to the discrepancy would consist perhaps in an appeal to the "respectable Scotchman" who presides over this pisciferous domain, who would probably enlighten us in this instance; and certainly provide us with as rich a haul as Mr. Lankester had, and at the same rate, viz., in exchange for that current coin of the realm that Scotchmen are not a whit behind the rest of Her Majesty's lieges in loving. We should be much indebted to Mr. Lankester if he would inform us on what authority he calls these Cradley fish, *P. rostratus*, as we poor *ignorami* always thought them to be *P. Lewisii* and *P. Lloydii*. It is well that this note should appear, if it only save any young enthusiast from instantly betaking himself to Cradley, fresh from your last number, and provided with too large a bag for the occasion. I believe, and the Quarry to us is familiar ground, that he would have his expectations clipped, and his temper tried. Still, do not, young geologist, turn aside from Cradley, but repair thither, with thy dinner in thy satchel, and thy hammer in thy pouch, prepared for a long day; and though thou verifiest not Mr. Lankester's account, forsooth, thou wilt not be disappointed.

Malleus.

ANNUAL MEETING OF GEOLOGISTS.

Dear Sir,—I am delighted to see the suggestions you have thrown out in last month's Geologist, and in order that something tangible may come of it, I would propose that a British Geological Association Meeting be held next year at the ancient city of Hereford; on the same plan as the British Archæological Association Meetings. From the number of railways, and readiness of access, Hereford is advisable for the London geologists, as also for the members of the Liverpool, Manchester and Oswestry Clubs who could reach it in four hours time, while the Cotswold, Malvern, and Warwickshire Clubs are close by. If the members of these associations alone would join, a very respectable meeting would be the consequence: and I need not say that the Woolhope members, who have their headquarters at Hereford, would leave no stone unturned to welcome their brethren of the hammer. Excursion-trains might be run each day to places of well-known geological interest: to Church Stretton and the Longmynd Hills; to Pontypool and the South Wales Basin; to Newnham and the Triassic cliffs of the Severn; to the Malverns; to the Woolhope Valley of elevation; to the Usk Silurians; to the Ludlow district and the Clee Hills. I will venture to say that no place in the kingdom could offer a more varied or interesting neighbourhood in which such an association might inagurate its annual gatherings. Last, but not least, Hereford offers plenty of accommodation for any number of geologists that might attend.

I am, dear Sir, yours faithfully,

Beaufort, August 19. G. P. Bevan.

THE BIBLICAL DATE OF MAN'S CREATION.

SIR,—A correspondent's enquiry in your July number, as to the authority for the date of man's creation on the earth being placed at about 4,000 years before the Christian era, deserves, I humbly think, an answer rather clearer and more to the point than is contained in Mr. L. Horner's somewhat lengthy discourse on this subject. That gentleman does not seem to be aware that there *have been* later commentators and critics on the chronology of the Bible than Archbishop Usher: such as Ffynes-Clinton, Brown, and others, whose industry as well as acumen on such subjects it is simply ridiculous to ignore. As these authors plainly show, any one may, without much trouble, verify for himself the period of 4,000 years, or *thereabouts*, from the dates and notices often supplied *in the Bible* itself. I give Ffynes Clinton's conclusions; but there *are* more modern works on the subject:—

From the creation (of man) to the flood	1,656	years.
From the flood to the call of Abraham	352	,,
From this call and the Exodus from Egypt...............	430	,,
In the Wilderness	40	,,
Time of Joshua and Judges	457 (A.)	,,
Time of Samuel	32 (B.)	,,
Time of the Kings and the captivity in Babylon	491	,,
Duration of the captivity	70	,,
Total..................................	3,528	years.
The return from this captivity took place soon after the conquest of Babylon by *Cyrus*, King of *Persia*, which is fixed, from profane history, at B.C.	536	,,

Therefore, adding these together, we have, B.C. 4,064 years. for the approximate date of the creation of man on the earth; I say approximate, because there are two slight gaps in the chronology, (marked A. and B. above), which cannot be filled up with absolute accuracy; but from internal evidence these *could* not have been much more than 40 years in duration; they *may* have been even less; I have here allowed that period for them. I may add that the first two periods in the above list are obtained by adding together the ages of the patriarchs before and after the flood, when the eldest son of each was born. The other dates are supplied, more or less, directly from the Bible itself.

It is also to be observed that some of the other ancient manuscripts of the Scriptures give somewhat different periods from these: such *e.g.*, as the Septuagint version, which adds 600 years more before the flood, and 600 more after it; making therefore altogether between 5,200 and 5,300 years from the creation of man and the birth of Christ; and rather over 7,000 years to the present time; and other manuscripts give, I believe, even a more extended term that this; but the difference between them all is not very great, as compared, at least, with geological computations and estimates of time; and the question would turn on the comparative authority of the several manuscripts.

I do not see, therefore, that any one has a right to treat the received period of 4,000 years, or *thereabouts*, as a mere figment or imagining of Usher, or any one else. As far as the authority of the Bible goes, (which is, at any rate, the most ancient *written* history in the world), 4,000 or 5,000 years (or on the largest computation not *much* more), seems clearly fixed as the period which elapsed between man's first appearance on the earth, and the beginning of the Christian era.

I am, Sir, yours obediently,

AN OLD SUBSCRIBER.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.

In the report of the proceedings of the Geological Society of London, given in our last number (p. 365), we inserted the abstract of Mr. Powrie's paper on the Old Red Sandstone of Forfarshire, in which it was stated that the author "believed that the marls and sandstones at Whiteness (near Arbroath) are not unconformable, as Sir Charles Lyell has represented them in his published section."

We are requested by Mr. Powrie to state, that having revisited Arbroath since his paper was read to the Geological Society, he has ascertained that Sir Charles Lyell's section was correct, and that the newer strata alluded to *are* uncomformable.—Ed. Geol.

Half a Day with the Cotswold Club.

Field natural history excursions diffuse a knowledge of nature's fair creation; they are not vain pursuits; the sedentary professional man, who is fond of natural science, can therein counteract that strain, stress and tension of the brain, which the wear and tear of life imposes. Besides, are they not agreeable vehicles of a mode of instruction not to be despised in these bookish days; of a kind of teaching, the value of which we can scarcely overrate, namely, of that peripatetic species that the "stout stagyrite delighted in." Perhaps we are not rash in suggesting that even Aristotle may have been the first founder of field-clubs!—He certainly, it appears, lectured while walking; the members of his club were dubbed "the walking philosophers," or peripatetics, and as to their president's knowledge of natural history, why "*cela va sans dire*:" since Cuvier, Forbes, Huxley and many another *savan* vouch for his careful study and sagacious insight; and have we not his "History of Animals" and other treatises akin to testify this. Whether further resemblance to our Field-clubs can be traced or not, it is not too much for us to indicate that perhaps they had their annual subscriptions, their dinners "*a la carte*," and their ladies' days. The latter is at least problematical. The Athenians possessed their accomplished hetærias, and surely it is not too mild to conjecture that ladies may have been admitted to the lecturing saunters of that age!—Be that as it may, field-clubs are an ancient institution, and, with this powerful sanction for them as such, it was not without a heightened pitch of expectation that we determined to get off for a day's ramble with one of the West of England Societies. We were told by a member that they usually reckoned on doing from twelve to fifteen miles at a turn; this much is not an inordinate dose, thought we, and will well oxygenate the blood. So we prepared to start "over the hills and far away," and join the Cotteswold Society. This society does not rank among the ephemerals; it is of some standing; its transactions are quoted; and it has inscribed on its list some choice names, such as Daubeny, Buckman, Strickland, Voelker, Wright, Brodie, and Symonds. Even compared with the Tyne Club, if not superior, it may certainly be bracketed with it. And then, what a noble field for these explorers, leaving out for the nonce the ecclesological, archæological, botanical and entomological richness of the shire and only regarding the cathedral city of Gloucester. North, south, east and west of it lies work for the hammer. Hay Hill silurians, Forest of Dean coal field, lias sections at Wainlode and Westbury of unsurpassable interest, and that superb range of oolite that so aptly and euphoniously designates the club in question, the "Cotteswold." Silurian, Oolitic and Liassic deposits, not mere patches, all stand within reach; and, as an invitation from Mr. A. Holland, M. P. for Evesham, had been accepted for the club to dine at his mansion, Dumbleton House, it was considered that the Middle Lias would form a "*piece de resistance*," with the "*entrees*" of Upper Lias. Nor was this the whole of the bill of fare. It would be tedious and egotistical on our part to intrude mere personal incidents; sufficient is it to recount that, at starting, early in the morning, one of fair promise, and all things looking "*couleur de rose*," we reached the station in good time, but not the train. For while inquiring for the *right* carriage, on one platform, like Professor Owen inquiring for the *right* whale, we learned to our mortification that our train had just glided off from the other platform, there being two stations at Gloucester. Chewing the cud of disappointment for three long hours was penance enough, and a degree worse than a Mediterranean lazarette. It came to an end at last. Dejection ceased—a start about noon enlivened our torpidity, and we began to look about us. Soon sped we, from Gloucester's fair tower "ye pride of Glostyre and ye Westyrne lande," and rattled along the iron road. The Midland rail from Gloucester passing Ashchurch a few miles beyond Cheltenham, traverses the Vale of Gloucester, with its fine breadth of corn-land, its varied scenery, and comfortable well-to-do looking farm homesteads. We soon left behind us Robin's Wood Hill, then neared Chosen Hill (so called in the vernacular) a similar eminence but with a quaint little turretted church on the top, perched amid trees, making one wonder how the parson gets up there, for we could almost presume nobody else ever goes. Looking out of the carriage window one could now readily fall in with the idea of Murchison as being no fancy, that the Severn was once a strait of the sea, that Breda, Dumbledon and Churchdown were islands, Leckhampton a lofty cliff, and the Cheltenham gravel beds ancient shingle beaches. After a call at Cheltenham we got to Ashchurch, and left the rail. Immediately outside the station, spoilt in effect by its nearness, is a pretty ivy clad church. Our destination now was Dumbleton Hill, one of the northern outliers of the Cotteswold region in the Vale of Evesham. Through losing the morning train we had seven miles of ground to get over before we could join the party. Setting off on foot, with a good will, albeit somewhat damped in ardour by the thought that this now would only be *half* a day with the Cotteswoldians, we took the turnpike-road along the valley. A group of mills extended to the right, more or less clothed, some with belts of larch, some with young ash coppice; while, looming to the left, lay Bredon Hill, dividing the vales of Gloucester and Evesham, and the largest isolated hill in the district; its outline sharp against the sky, forming a gentle elliptical curve, and the base occupied by a cordon of farm-houses embosomed in orchards. A well made road of Lias marlstone faced with Bristol stone (*i.e.* carboniferous limestone) gave us good walking, while cottages of the true English character were dispersed along the roadside with clumps of the homely hollyhock in dark puce or lemon coloured blooms, screening, perhaps, a view of straw-capped beehives and with mostly a vigorous well trained plum or apricot against the south end of the house, betokening, as we thought, a kind and considerate landlord. We trust we are not wrong. Travelling onward, certain stone-heaps arranged by the roadside, were examined; the materials pronounced to be of Drift, and Pleistocene age, large pebbles they were, oval, smooth and hard, breaking with schistous fracture, and showing true crystalline structure. They seemed to be collected for road repairing, but whence they were brought we did not ascertain, Piles of marlstone from the neighbouring quarries on the hill now appeared alongside the road; these were quite a treat to look into, but sadly tantalizing withal. We anxiously peered at the semi-enshrined fossils, and reluctantly left them, our small trimming hammers were unequal to the fray, which required a tool with at least a three or four pound head, to shiver such refractory stuff as tough marlstone rock. A pleasant sight was it to see busy teams and men in every field "carrying the wheat," some of these swarthy sons of the soil we descried under a hedge reposing; they were discussing, in an interval of labour, their cider and bread and cheese. Accosting them, we inquired the way to Beckford Inn. "Three mile," said one, a stalwart reaper; "will'ee lend us your hammer?"—"What to do," rejoined we, "to cut our bahyt (*i. e.* bait or food) wi'," said the fellow, good humouredly. It could not be spared, so we pushed on, not omitting to entertain the inference that the dairy produce must be *very* hard in those parts, and reached Beckford Inn. This well known hotel stands near the cross roads. Here, we thought, some track of the Cotteswoldlians must be detected. A young crinolined and ringletted daughter of Boniface appeared, and soon alleviated hopes and fears with news, "that the gents were gone up to Alderton stone quarry." Resuming our way—we had not gone far, ere we learnt from a cow-boy that the people were "up in the brickyard;" and there they were sure enough, near upon thirty of them, scrutinizing mother earth, and intent upon their work. A very large "brick pit" it was, extending into the very base of Dumbleton Hill. This, as I said before, is one of the outliers, moored as it were off the northern chain of the Cotteswold. The others are Bredon, Stanley, Oxenton, Churchdown and Robin's Wood Hill, all truly isolated; a few others partake of the peninsular character. Their formation is identical; and what we shall say of Dumbleton will apply to the rest.

At the "Brickfield" they were excavating a fine stiff clay, making part of the Upper Lias, called "the A. raricostatus Zone," after the ammonite of that name, which pervades it. Some good Lias fossils were here turned up, among which we noticed ammonites, crenatulæ, cuculleæ and gryphites; it also yielded to the explorers' havresacs some admixture of fossils of "marlstone type, indicating, as some thought, the presence of true "passage-beds" between the Lower and Middle Lias, To this fast growing use of the expression "passage-beds" we venture to take exception, unless it be used with proper restriction. Every formation, every bed almost, is, in a certain sense, a "passage-bed." "*Natura non facit saltum*," Ascending the spur of the hill we quit the Lower Lias beds that form the lower floor of the vale and basement of the hill, thence passing over the marlstones of the middle Lias, near the top of which the marlstone rock is exposed by frequent quarrying for road-metal, we come to the Upper Lias entablature of the hill. This consists of blue and yellowish shales, through which, with irregular course, runs the "Fish-bed," a band of "cement-stones," not worked in these parts, but of considerable economic value. They are worked in Yorkshire, at Boulogne, and particularly at De Vagoy, in France. Also in Canada and in the States of America. Roman cement is fabricated from them: they are first burnt, then ground to powder, and packed closely in air-tight barrels on account of their strong affinity for the moisture of the atmosphere. Tertiary concretions, it is well known, are also used for the same purpose.

Some of the party were now at the marlstone, of which I will say a word, The under zones of Middle Lias, from being destitute of value, are never excavated, and are, therefore, only to be got at in a chance drain, or deep ditch or lane cutting. Concealment is the rule till we come to the marlstone. This material is of undoubted toughness; the quarrymen call one bed of it the "Leather Bed;" still, unlike leather, it gives out a clear ringing sound from the impact of the hammer. Here the company, encouraged by the sight of ammonites, belemnites, myacites, and limæ, ostreæ, monotidæ, modiolæ and brachiopoda, toiled away at the rock; and the click, click of the hammer resounded through the coppice.

Meanwhile, many of the older hands, shutting their eyes to the blandishments of the marlstone, push upward and attack the "Fish Bed" of the Upper Lias, which they well know contains the choicest specimens of fish, crustacean, and insect, nay, even of reptilian remains, for this is the "Saurian Zone."

Leptolepis concentricus was now found by Mr. Norman; a fine *Pachycormus* by Mr. Holland, and a series of vertebræ of a species of *Icthyosaurus* by Mr. Moore. As a "Saurian Zone," it is well known all through Europe, since nothing can be more constant and persistent than the course of the Upper Lias formation. Indeed, nowhere can Geology point to a truer or more extended horizon. Under the Shales we detect the Leptæna Bed, a band of but few inches in thickness yet embracing numerous tiny shells, mostly brachiopods, but some Nuculæ, &c. Under and over the Fish Bed are shales remarkable for their perfect lamination; splitting them open with a clasp knife we have under our eye, a table of contents, curious to note, and deeply instructive. Ripple-marked furrows, sea-weed, ever and anon disposed in places only whither the eddying of the current had drifted it, just as we may see any day on the strands of our own sea-girt isle. To feed on these alga pastures are the crustaceans) prawn-like in form and size, in no contemptible number; and, as a final exemplification of the cyclical law of life, here lurk the rapacious fish and predaceous cephalopod, the armed cuttle and belemnite, with other such flesh-eaters, allured by the tempting bait. A fish that marvellously resembles many Liassic forms is the capelin (*Mallotus villosus*) of our breakfast tables, alike palatable to us as to the stunted Esquimaux or Greenlander.*

So fossiliferous and prolific are these shales and nodules, that one could never tire of working at them, and when the company retired to Dumbleton House there was still a treat in store: they were delighted with the unrivalled collection made by Miss Holland from the quarries adjacent,—a series of Liassic forms of rare perfection and value, arranged, too, with that peculiar neatness and accuracy that ladies alone possess. This exquisite suite of fish-bed fossils was the theme of admiration. It comprised good reptilian remains, fish, crustacea and insects, the latter of transcendent delicacy.

We were much struck with a collection made by Mr. Holland at Mount Lebanus, in Syria. Many of the fossils were of the Jurassic caste, and almost looked like intimate acquaintances.

The naturalists now assembled in the library included some distinguished men, besides the president of the "Cotteswold," Captain Guise, were Mr. S. P. Woodward, of the British Museum, the Rev. W. S. Symonds, President of the Malvern Club. Charles Moore, of Bath, who so surprised the "savants" of the British Association some time since by his foretelling what organism each fish-bed nodule contained, ere, with a blow from his hammer, he laid open before his astonished auditory the fossil he had predicted as its nucleus. Drs Wright, Beach, Bird and Warner, the Revs. Norwood, Atwood, Hepworth, Major Barnard, Messrs, Dent, of Sudeley, Bowley, Copeland and Walker.

Mr. Holland had provided a sumptuous repast for his brother naturalists, of which about twenty-eight gentlemen partook. The after dinner the reading of papers took place after the usual preliminary toasts. One of considerable interest was by the Rev. W. S. Symonds, F.G.S, on the Drifts of the Severn, Avon, Wye and Usk, going well into the physical geology of the district, and

* Professor Owen states that *Mallotus villosus* is found in clay nodules of unknown age in Greenland.

recognizing with Prestwich, and working out the distinction between the high level and low level drifts of the Pleistocene era, with pertinent observations on lacustrine and river action. Mr. Symonds strongly appealed to his fellow members to aid him with their individual observations, by noting particularly the organic contents of the drifts; a clue might thereby be obtained that would elucidate many of the pleistocene phenomena.

Thereon ensued a discussion, sustained in a lively and erudite manner, by Messrs. Moore and Woodward, the latter contributing a just and discriminating account of the palæontological differences between high level and low level "mammalia," with geological remarks on the habits of the tropical Bison and the larger Pachyderms, such as *Elephas antiquus* and *E. primigenius*, glancing at their aptitude for enduring the rigor of the glacial epoch.

Another paper was communicated by Mr. Frederick Smithe on the Upper Lias of Churchdown Hill, a similar formation to Dumbleton, the writer, after giving a brief resumé of the divisions and sub-divisions of the Lias and the synonyms of the subordinate zones as used by the chief European authors, restricted his attention to the "Ammonites communis Zone" of the Upper Lias, which reposes on the marlstone, and treated this zone in its development at Churchdown—first lithologically, then palæontologically.

As to the included beds, the A communis Zone comprises (1), on top the Laminated Shales; (2), the Fish Beds within them; (3), the Leptæna Bed lying beneath the "Alga-bed;" (4), the Marlstone upper beds, embracing a course of siliceous nodules. The author had exhumed remains of *Teleosaurus*, and *Pterodactytus*, *Colæia*, a not uncommon Lias crustacean, *Pachycormus*, *Tetragonalepis concentricus*, *Lepidolepis ovalis* and *dapedius;* also, *Belemnosepia*, *Ammonites*, and such molluscan forms as *Ostræa*, *Nucula*, *Arca*, *Modiola*, *Monotis* and *Posidonomya*.

Rostellaria being nearly the only gasteropod in the catalogue. In short, for a locality considered so poor in comparison with the Somersetshire deposits, not a bad harvest.

The president, at the close of a most enjoyable day, admitted to be one of the most delightful meets of the season, invited the members to attend, on the 17th of September, at Worcester, when Sir Charles Hastings, the Bishop of the diocese, and M. Chaillu, the African traveller, are expected.

NOTES AND QUERIES.

Stone Weapon in a Fossil Deer's Skull.—Sir,—In the notice you took of my pamphlet in the "Geologist" of June last, entitled "Remarks on the Flint Instruments found at Amiens and Abbeville in connection with the Glacial Theory," you consider that it would be highly desirable for me to elucidate one remarkable statement made by a more particular statement of the facts. The statement you allude to I consider to be that in italics: "I can prove that the Irish Elk was contemporaneous with man, having seen a stone hammer sticking in the skull of one, and also the heads of others which had been perforated by the same kind of weapon."

I can now give you full satisfaction on that subject, having *now in my possession* the identical stone hammer, or rather stone axe, or celt, which was found in the frontal bone of that *Megaceros Hibernicus;* the head itself, I am

Fig. 1.—Stone hatchet found in skull of Irish Elk. Scale, half natural size.

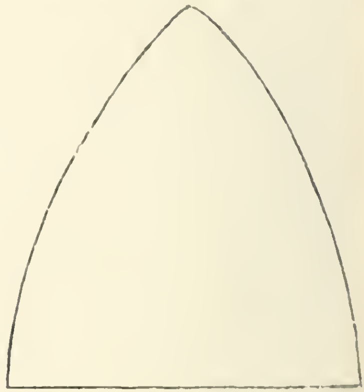


Fig. 2.—Section of celt, showing the way it slopes at the large end.

sorry to say, was sold separately to the late Dr. Ball, of Trinity College, Dublin.

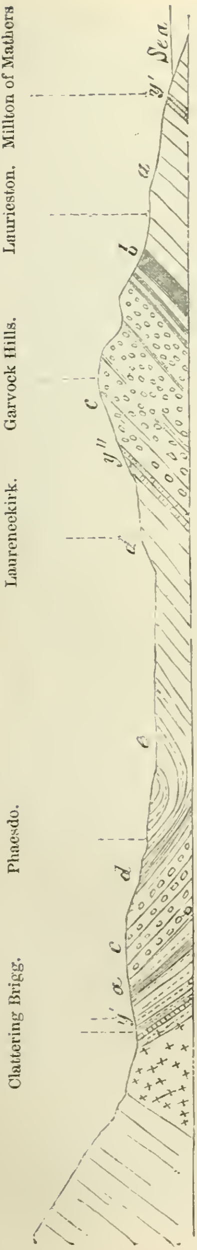
I beg to send you a sketch of the stone axe, or celt, and a copy of the certificate from Mr. Glennen, the person who found it, who also mentioned to me that the late Colonel Bruin of Oak Park, county Carlow, had found upon his property the head of a Megaceros having the frontal bone perforated by a stone celt which weighed seven and a-half pounds, and was found sticking in the skull.

Copy of Mr. Glennon's Certificate.

This fine stone celt was found by Richard Glennon and James Nolan, of Batchelors-walk, Dublin, stuck in the frontal bone of the female Giant Deer of Ireland, at a place called Lough Gur, ten miles from Limerick, on the Cork road. This is Mr. Glennon's account of the hatchet, or celt, of which this is an outline:—Its length is eight inches and five-eighths; breadth at the broadest part three inches and five-eighths; it weighs three and a-half pounds; the greatest thickness is at the dotted line *a b*, which is one inch and seven-eighths, when it gradually slopes down to a sharp edge; its greatest thickness at the small end is at the dotted line *c d*, where it is one inch and three-quarters, when it slopes to a point.

Mr. Glennon lives at No. 3, Suffolk-street, Dublin, and is a dealer in minerals, &c. I believe he has now two fine heads of the *Megaceros Hibernicus* which he would be glad to sell to any of your readers who might have a desire to purchase them.—I remain, Sir, your obedient servant, R. Wauchope.

A Moved Moss at Falkirk. Very recently a moss hill, situated about two miles from the Slomanan Railway station, and measuring in extent about 30 acres, was lifted by a flood, which carried it to the distance of 500 yards. Heaps of the deposit lie about in every direction, which for the time being has blocked up the road. The hill was overturned and broken up by the water, which had been accumulated to an extraordinary degree, by the heavy rains of the previous four or five days. The strangeness of the occurrence has attracted crowds to witness the effects of so gigantic a removal.



Section across the Old Red formation of Kincardine.

GEOLOGY OF STONEHAVEN.—SIR,—Observing an enquiry as to the nature of the geology of the neighbourhood of Stonehaven in the "Notes and Queries" of your number for July, by some one subscribing himself S.M., I send you the annexed section extending across the Old Red formation of the county of Kincardine from the schists of the Cairn O'Mount, in the Grampian range, to the sea at Millton of Mathers, with a brief description of these formations as there found, hoping it may be useful to S.M. in aiding his researches there, as although the rocks at Stonehaven are identical both in character and order of sequence with those of the section, yet several unexplained irregularities exist, rendering this a very interesting field for research.

It will be discerned from the section that the sandstones of Kincardineshire are twice brought up for the inspection of the geologist. Unconformably overlying the schists and clay slates of the Grampians from which they are cut off by considerable trappean outbursts, they first dip at a very high angle towards the south-east. Descending from the Grampians we rise in the series of rocks until we reach a synclinal line, crossing which we again pass over the same formations, until, on reaching the sea at Millton of Mathers, the very lowermost beds of the series are again exposed. At that part of the section where the syncline exists the rocks are quite hidden by the overlying Boulder clay—its exact position, I am, consequently, unable to point out; but from my knowledge of its direction in the neighbouring county of Forfar, where the same series of rocks are formed, I should expect it to pass along a little south of Fettercairn, Phaesdo House, &c.

In describing these formations we will commence with the lowermost beds as found at either end of the section, ending with the uppermost at the synclinal line. Thus first we have at the upper part of any line of section, a series of dull deep red grits, *a*, more or less indurated, represented at Millton of Mathers by soft sandstones and marls. Very low in these gritty beds is found a bed of concretionary limestone, *y*, which has formerly been wrought to some extent both at Clattering Brigg and Millton of Mathers. I am not aware that any fossil has yet been found in these grits or limestones, near to the Clattering Brigg; but in a quarry from which rather indurated red flagstones have been taken, the surfaces of these flagstones are occasionally found covered with the impressions of rain drops, the trails seemingly of crustacea and annelids, and often finely ripple-marked. Similar flags and occupying the same low place in these rocks, many beautifully covered with similar markings, were some time ago saved from destruction by the care of the Rev. Hugh Mitchell, from a road then in the course of being made in the village of Ferryden in Forfarshire. These grits, or their representatives, pass upwards into an enormously developed conglomerate, *c*, immediately east of the line of section. The Fenalla range of hills is almost entirely composed of this; and to the south it is again upheaved in very great mass in the Garvock range, where, however, it is considerably broken up by igneous irruptions. The grey, flaggy beds, with their shales and thin-bedded flagstones, *b*, from which the Arbroath pavement has been so largly obtained, are intercalated in the lower portions of this conglomerate; and although not so largely developed in the conglomerates of Kincardineshire as in that of the county of Forfar, yet these flaggy beds are not unrepresented there; the fossiliferous deposits of Cauterland Den, which the Rev. Hugh Mitchell's explorations have made so well known, belong to these beds· they are also found in the rocks in the bay of Stonehaven, where I have dug out pieces of shale similar to that of Cauterland Den, with *Parka decipiens*, &c., here, however, they are only to be reached at low water. Those beds are particularly interesting as the only part of either the Kincardineshire or Forfarshire rocks that have proved undoubtedly, in some instances, richly fossiliferous—to them belong the Farnell shales, with their beautifully preserved small ganoid and other fishes, crustacea, &c. The Yealing and Sidlaw shales, which Mr. W. McNicoll's acute researches have proved to be almost equally rich in ichthyic remains, the Leysmill flagstones, with their unequalled specimens of Cephalaspis, the Carmyllie Quarries from which the finest of all the specimens of *Pterygotus Anglicus* has been obtained, all form part of these intercalated flagstones and shales. The conglomerate is again overlaid by, or rather passes into, reddish, generally highly micaceous sandstones, *d*, from which occasional specimens of Cephalaspis may be obtained; and these again by dull coloured deep red sandstones and shales, *e*, whose disintegration has again given the peculiarly red colour to the soil of that part of Kincardineshire known as the "How of the Mearns." These formations are by no means of an uniform depth, but may in all reach a thickness of not less than three thousand feet.

In concluding this short sketch of the Old Red Sandstones of Kincardineshire, I would point out a few of the localities where, these may be most profitably examined. First in importance is the section by the coast; the well-defined strata in Stonehaven Bay, in almost every instance dipping at nearly right angles from the coast, contain a record not even easily read. To the south the true position of the conglomerate, as exposed in the cliffs along by that fine old ruin, Dunnotou Castle, is perhaps more difficult to ascertain—every ravine and rivulet along the coast would therefore require carefully to be followed up, and wherever the rock may be exposed, its character, position, and dip, if this can be observed, carefully taken down. The bed of the Carron ought fully to be explored, and none of its small tributaries left unvisited,—the railway-cuttings afford several fine sections. Following the coast-line to the south-west, the bed of the stream falling into the sea, near by Katterline Harbour, may contain much valuable information; and lastly, the Bervie water, although affording no continuous section, shows the whole series in detached portions. All quarries should be visited, the sandstones and shales fully examined, and, above all, the workmen encouraged to preserve any curious looking markings that may be found.

To the mere fossil-collector the Forfarshire and Kincardineshire rocks offer an uninviting field, and many an hour's hard work will often yield barely a recognizable organism; but to the true geologist, an abundant return of profitable information may be found in studying the nature, sequence, and relation of these rocks as they are exhibited in the bold cliffs and picturesque ravines along the coast.—Yours, &c., J. Powrie.

New Fossil Locality of Mollusca in the Scottish Old Red.—The new deposit of fossil organic remains in the *Old Red Sandstone* at Dron, as noticed by me in the last "Geologist," becomes, upon further examination, of the greatest interest as well as theoretic importance in a scientific point of view. I shall, therefore, in a few details give the substance of the discovery, showing the general bearings, relations, and character of the rocks in the district, and furnishing materials, whether of controversy or agreement, for future investigation among geologists.

The district in question occupies a central position in Strathearn, skirting the Ochils on the south, and trending northerly towards the hill of Moncreiffe, which forms an outlier of the Sidlaws. The intermediate space of nearly three miles in breadth, is filled with deep alluvial clays, peat, and gravels, and forms an extension of the Carse of Gowrie deposits intersected by the river Tay. An elevated ridge occurs at Dron, near the church, which rises steeply towards the west; it is about a mile in length, terminating in the red sandstone quarries of Pitkeathly, and separated by a deep hollow from the Ochil range of trap-porphyry. The outcrop of the new fossil beds is on the slope to the south of this hollow, forming an insulated little basin of blue marly clays, interlaminated with hard micaceous flagstones, and showing all round indications of great denudation.

Extending the view eastward, the basin-estuary of the Tay opens up widely, enclosing the various members of the Old Red Sandstone series—the conglomerate of Glenferg, the yellow-spotted beds of Abernethy, the cornstone of Clunie and Newbigh, the tilestones of Parkhill, and all of which have their correspondents at Clashbennie, Meurie, Inchture, Balruddery, Tealing, Carmylie, and Forfar. The intermediate space westerly, from the Ochils to the Grampians, averaging fifteen to twenty miles in breadth, is occupied with the lower Devonian series, embracing all the rich fossiliferous rocks of Forfarshire, the deep-red beds towards Birnam, Crief, Donne, and Dumblane; and which, in some of the members near Gleneagles and Dalmyatt, contain specimens of *Parka decipiens*, *Pteraspis*, and *Cephalaspis*. The outgoing of the whole, east and west, from the terminating shores of Arbroath and Montrose, being the environs of Lochlomond and Dumbarton.

The relation of every one of the above series of rocks, forming one geological group, may be traced in the vicinity of Dron in juxta position each to each in an easy forenoon walk. The depth of the deposit, as exposed at the mill-dam, varies from twenty to thirty feet. The newly-discovered fossil-bed—so attractive yet to be to science—forms the centre-point which underlies the whole. It stretches along the narrow ravine to the foot of the Ochils, where it becomes enclosed among the trap-porphyries, and where a fine waterfall (the Ramheugh) plunges over its indurated edges. The "cornstone" of the series is not now observable, being covered up by the improvements of modern husbandry; but it has been long known as existing, *in situ*, in the neighbouring fields. A few hundred yards distant the quarries of Pitkeathly—the *Holoptychian* red—shows the position of these beds. And, last of all, an insulated section of what I regard as the Dura Den *yellow* sandstone, and ferruginous marls, crowns all the underlying strata; it is exposed to the depth of thirty to forty feet in the woods of Wester-Dron farm, and the nearest continuation of which is ten miles off, at Glenvale, on the Lomonds. When fossils were not sought after, or formed no attraction to the curious, these upper rocks have been extensively worked, and all their *ganoid* treasures, if ever exhumed, lost to science.

The *organic remains* just discovered in the lower grey sandstone of the series consist of shells and microscopic crustacea, and are, so far as I am aware, the first specimens of *conchifera* yet detected in any of our Scottish Devonian rocks. The discovery is all the more important that so few of the class have been found in any of the numerous localities of the Old Red—one or two in England, more abundantly in Russia, and even there of comparatively rare occurrence. "One shell, however, the *Atrypa reticularis*," says the author of Siluria, "ranges even to the furthest known geographical limits of the Devonian rocks; to Armenia, the Caucasus, and China on the east, and to the Devonian deposits of America on the west.*"

I forwarded a small slab of the deposit to Mr. Salter, who has returned for answer, as the result of his examination, "Though very obscure, there cannot be much doubt of the bivalve shell being a *Modiola* or related genus; but it is so imperfect that I should not like to say whether this very thin shell is a marine one or not. The same with the Entomostraca. They may be *Cypris*, but are quite as likely *Cythere*..... I may further mention that a shell somewhat like is found in the Lower Old Red of Shropshire, accompanied by marine genera of Entomostraca. The species is probably new." This interesting fossiliferous slab is now placed in Jermyn-street Museum.

There are, in addition to the above, several other forms of mollusca, one of which resembles the genus *Atrypa*, another is like the typical *Spirifer*, and some are so thin and broken as scarcely to present their true characteristics. They are, however, sufficiently numerous, and to be easily extracted from their soft marly matrix. Better specimens are therefore to be looked for, and probably also various new genera in a deposit otherwise so rich in organic forms of marine life. Some of the shells are smooth, and others deeply and beautifully striated. Some are so extremely filmy as to be almost detached by the breath, or break by a slight impression of the nail.

The Entomostraca are exceedingly numerous, some microscopically minute, and others large enough to be examined by the naked eye. A bed of fully an inch thick is entirely composed of myriads of these organisms, fresh in colour, and perfect in outline and structure as when they sported in the waters and shallows of the Devonian seas. The mass is extremely friable and brittle, as consisting chiefly of these minute bodies themselves, and a soft calcareous or aluminous matrix of a light bluish colour. Organisms of the same family are distributed up and down in the thirty feet of exposed rock, as if floating everywhere in the turbid water, they had dropped at random into the muddy silts. The richer portion is towards the base of the cliff, and consists almost exclusively of the creatures bodies themselves, agglutinated by a thin paste of calcareous shale.

I shall now conclude with a few general remarks, as serving to show the relations and theoretic value of this new fossil locality, and the bearings more especially upon our Scottish palæontology, some recent northern conclusions of which may be thereby disturbed.

1. Do these grey flagstones and indurated shales form part of the Devonian system, or true *Scottish Old Red* sandstone? I have in my own mind not the slightest doubt about the answer that must be given to the question. The other members of the series are all in the immediate vicinity; and from Parkhill to Gleneagles—thirty miles in linear distance along the slope of the Ochil range—the grey and blue coloured tilestones can be distinctly traced throughout, feathering out and in among the traps and in various places exhibiting the same texture and marly character as the Dron deposit. At the same time it has to be stated that some regard this as the *under Carboniferous* series. Mr. Powrie, upon a short inspection, all but concluded that it was; and in corroboration of these views, I have to mention that pits in search of coal have been

* Siluria, 3rd edition, p. 297.

successively sunk for upwards of a century, and the belief generally prevails in the district that the combustible substance is there.

2. What, and where, are the correlates of the fossils now detected here for the first time? I have lying on the table while I write a specimen from Linksfield, near Elgin, of the "Cypris globosa bed" of marls, and which, from these and other organisms, are generally regarded as belonging to the Triassic and the Wealden. My eye detects no difference in either the character of the matrix or the forms and contour of the crustacea organisms in the Dron and the Elgin specimens. Both are of the same thickness, the same colour, the same shelly texture, and the *Entromostraca* are numerically the same in the composition of the respective deposits. Further researches may possibly unfold more resemblances.

3. The student of physical geology will find much to interest him in the district; in the general structure and variety of the trappean formations, the vast accumulations of drift in the strath, the boulder clays along the slopes of the hills and in the lateral valleys, and the various ravines formed by the mountain streams by the incessant and ever-wearing action of ages. But Glenfarg will form one of his chief attractions, from its many natural beauties and exuberant richness in many rare minerals. The entire family of Zeolites are there:—*Thomsonite*, *Stilbite*, *Datholite*, *Heulandite*, *Analcime*, *Prehnite*, and the newly analized *Fargite*, long described as *Galeatite* from its extreme whiteness.—Dr. Anderson, Newburgh, Fifeshire.

Fossil Trees at Haughland.—A short time since when Mr. William Young, builder, Bishopmill, was digging a well at Haughland, near Palmercross, a very unexpected discovery was made. First, in digging the well, the workmen cut through two feet of good mould, a depth of soil of which many of our farms would be glad. There was then soft sand mixed with some clay for other five feet downwards. This was followed by six inches of moss, then six inches of sand underlying the moss, and these three strata were followed by a bed of strong blue clay eighteen inches or so in thickness. Next came two feet and a-half of black moss at the depth of nearly ten feet from the surface, and here was found a birch tree with its branches, some of them four inches in diameter, embedded in the moss, lying along as they had been laid when the tree was uprooted. A great part of the tree was in a comparatively good state of preservation, and when pressed the water oozed through it like a sponge. It is hard, black, and of course very heavy. We may remark that this fossil-tree grew ten feet beneath what is now the river Lossie, which flows within two hundred yards of the spot where it was found. Geologists are agreed that the great plain extending from Aldroughty to Birnie was once covered by a lake, but the tree found beneath the bed of blue clay shows it was a forest before it was a lake, and the bed of sand both above and beneath the moss in which the tree was found strongly favours the belief that the land in the plain mentioned has been oftener than once submerged by the sea.

The Minerals of the Metallic Veins of Frieberg. (Extract in the *Annales des Mines*, by M. Delesse, from the article "Die mineralien der Freiberger Erzgange Zusammengestellt, von C. Weiss, mit Bemerkungen von Bernhard Cotta," in the *Berg und Hüttenmannische Zeitung*, 1860. Translated from the French by H. C. Salmon, F.G.S., F.C.S.)—I have proposed to myself to compare the mineralogical composition of the metalliferous veins of Freiberg —a task which has been accomplished by the aid of the numerous documents possessed on this subject, and by the assistance of one of my pupils, M. Weiss. It is summed up in the following table, which gives the mineralogical composition of our four systems of metalliferous veins. The minerals most frequently met with are inserted in italics.

Numbers of order.	I. RICH IN QUARTZ. (Edle quarz formation.)	Numbers of order.	II. PYRITE AND LEAD. (Pyritische Bleiformation.)	Numbers of order.	III. RICH IN LEAD. (Edle Bleiformation.)	Numbers of order.	IV. BARYTE AND LEAD. (Baritische Bleiformation.)
1	*Quartz.*	1	*Quartz.*	1	*Quartz.*	1	Quartz.
		2	Opal.	2	Opal.	2	Opal or Hornstone.
						3	*Fluor Spar.*
						4	*Sulphate of Baryta.*
2	Carbonate of Lime.	3	Carbonate of Lime.	3	Carbonate of Lime.	5	Carbonate of Lime.
3	Dolomite.	4	Dolomite.	4	Dolomite.	6	Dolomite.
4	Pearl-spar (Ferro-manganesian Carbonate of Lime).	5	Pearl-spar.	5	Pearl-spar.	7	Pearl-spar.
				6	Magnesian Carb. of Lime.	8	Magnesian Carb. of Lime.
5	Spathic Iron.	6	Spathic Iron.	7	Spathic Iron.	9	Spathic Iron.
6	Carbonate of Manganese.	7	Carbonate of Manganeze.	8	*Carbonate of Manganese.*		
		8	Chlorite.				
7	Galena.	9	*Galena.*	9	*Galena.*	10	*Galena.*
8	Bournonite.						
9	Polybasite.	10	Polybasite.	10	Polybasite.	11	Polybasite.
10	Stephanite.			11	Stephanite.	12	Stephanite.
		11	Sulphide of Silver.	12	Sulphide of Silver.	13	Sulphide of Silver.
				13	Weisgiltigerz.		
11	Grey Copper.	12	Grey Copper.	14	Grey Copper.	14	Grey Copper.
		13	Bornite.				
12	Copper Pyrites.	14	Copper Pyrites.	15	Copper Pyrites.	15	Copper Pyrites.
13	Arsenical Pyrites.	15	*Arsenical Pyrites.*	16	Arsenical Pyrites.		
14	Marcasite.	16	*Marcasite.*	17	Marcasite.	16	Marcasite.
15	Iron Pyrites.	17	Iron Pyrites.	18	Iron Pyrites.	17	Iron Pyrites.
16	Blende.	18	*Blende.*	19	*Blende.*	18	Blende.
17	Kermes.						
18	Pyrargyrite.	19	Pyrargyrite.	20	Pyrargyrite.	19	Pyrargyrite.
						20	Proustite.

If we now search out what are the chemical elements of the four systems of metalliferous veins of Freiberg, we have the table following. In it the elements are nearly arranged according to their frequency. Those which are found at the head of the list are the most abundant, but there is some uncertainty in the classification of those which are in the middle. Although Oxygen, Hydrogen, and Carbon play an important part, they are placed at the end, as not being characteristic.

I.	II.	III.	IV.
Si	Si	Ca	Ba
S	S	Si	Si
Fe	Fe	S	Ca
As	Zn	Pb	Fl
Pb	Pb	Fe	S
Zn	Cu	Zu	Pb
Sb	As	As	Zn
Ca	Ca	Cu	Cu
Cu	Ag	Ag	Fe
Ag	Mg	Mn	As
Mn	Mn	Mg	Sb
Ba	Al	Ba	Mg
Fl	Sb	Fl	Ag
St	Ba	Al	Mn
Mg	Fl	Sb	Ni
Al	Cl	Cl	Co
Ph	Ph	Ph	Al
Bi	Co	Ur	Ph
Au	Sn	Ca	Cl
Cd ?	Ca	Au	Bi
O	Au	O	Wo
H	O	H	Ti
C	H	C	Ur
	C		Au ?
			Ca ?
			Se ?
			O
			H
			C
Total 23	24	23	29

By uniting into one single alphabetical series all the élements of the four systems of veins, we obtain the following table, in regard to which are also shown the elements which are wanting.

ELEMENTS.

Found.		Not Found.	
Aluminium.	Magnesium.	Boron.	Palladium.
Antimony.	Manganese.	Bromine.	Platinum.
Arsenic.	Nickel.	Cerium.	Potassium.
Barium.	Oxygen.	Chrome.	Ruthenium.
Bismuth.	Phosphorus.	Didymium.	Rhodium.
Carbon.	Selenium.	Erbium.	Sodium.

Elements.

Found.		Not Found.	
Calcium.	Silicium.	Glucium.	Tantalum.
Cadmium.	Sulphur.	Iridium.	Tellurium.
Chlorine.	Strontium.	Iodine.	Terbium.
Cobalt.	Silver.	Lanthanium.	Thorium.
Copper.	Scheelium.	Lithium.	Vanadium.
Fluorine.	Titanium.	Murcury.	Yttrium.
Gold.	Tin.	Molybderum.	Zirconium.
Hydrogen.	Uranium.	Nitrogen.	
Iron.	Zinc.	Niobium.	
Lead.		Osmium.	

This table shows clearly the great difference which exists between the chemical composition of the Frieberg veins and that of most rocks. Potash and soda is completely wanting, and alumina is only met with in a very small quantity.* Are we not justified in concluding, from this single fact, that their mode of formation is not the same as that of the eruptive rocks, any more than of the sedimentary or metamorphic rocks?

Singular Objects in Sand near Canterbury—Mammalian Remains—Submerged Trees, &c., at Herne Bay.—Dear Sir,—Curiosity led me yesterday into a sand-pit at Hackington, near this city, and I was struck with the appearance which it presented. The weather has lately been very hot, but at the time I was there it blew a brisk breeze, which occasioned the dry sand to run down from above, as we sometimes see it run through an hour-glass. As it trickled down, it left standing out clear from the face of the cliff numerous small cylindrical bodies, varying from half an inch to an inch in diameter, their surface covered with small protuberances or warts, and much resembling some corals, but so fragile as hardly to bear handling. Their position was mostly perpendicular, but some were lying horizontally, and they varied in length from a few inches to two feet. The workmen said they were occasioned by the wind, as they never observed them but when there was a strong breeze blowing against the sand. This latter was of various colours, from a bright red to a yellowish white, most probably caused by iron, as there are a great many small masses of iron-stone mixed with the sand. Now I am at a loss to know whether these objects owe their formation to iron in some of its combinations acting upon the sand, or whether they have been corals which were covered up by the sand when at the bottom of a shallow sea, and as the carbonate of lime decomposed, its place was gradually supplied by the surrounding sand. A stratum of brick-earth of about fourteen feet in thickness caps the sand, which is worked out to about forty feet down to the water.

A few days since I walked along the sea shore from Whitstable to Hampton, near Herne Bay. A great many stones are here collected for the purpose of making cement. These stones are found in the clay, or they fall down as the soil crumbles away from them, and strew the shore, whilst many of them have, very curiously, the forms of Algæ and other sea-weeds impressed upon them. The stems of the Algæ are well defined, and the smaller weeds are twisted about in all directions upon the surface of the stones. These latter, when they are *in situ*, are surrounded by an envelope of crystals of talc, very brittle, but sparkling in lustre; the covering is about three quarters of an inch thick. In each stone there is a nucleus much like a fossil echinus, around which the

* Compare the translator's papers on the Chemical Composition of Rocks in vol. ii. of the "Geologist."

silicate of magnesia accumulates. A smart blow shivers the mass, and leaves the nucleus bare. Great abundance of talc in various forms strews the shore resembling leaves, flat plates, &c.

The tusks and bones of the *Elephas primigenius* are found here when the cliff falls down—a circumstance which frequently occurs when the sea undermines it.

Nearly opposite this place, when the spring-tides recede, a number of trunks and branches of large trees are seen at low-water mark, partially buried in the mud, and evidently the denizens of some ancient wood which has been submerged when the sea encroached on these shores. The wood is black, and when dry as hard as ebony, making good posts for gates, field-rollers, &c.

I may also mention that about a mile out at sea, off Hampton, is the Pan sand, where large quantities of Roman pottery have been dredged up. Several fine pateræ of Samian ware have been found, and lately a *mortarium* in good preservation. This last was sent to the British Museum. It is a little curious that within these few weeks some pateræ and other Roman utensils quite similar to those found on the Pan sand have been dug up at St. Sepulchre's, Canterbury. In some instances the same makers' names were stamped upon the articles dug up at Canterbury and upon those found at sea.

I send you these rough sketches of incidents occurring in my rambles, presuming they may be of some slight interest to your readers.—I am very faithfully yours, John Brent, Barton.

[The marks noticed in the sand are probably the old tubes of Sabellæ, if the sand is of marine origin; or worm-tubes if a freshwater deposit. It would be worth while for the observer to compare the tubes formed now by the *Sabella* common in the sands of the Kentish shore with the objects he describes. I have seen what I believe to be Sabella-tubes in the Lower Greensand in a cutting on the camp-ground at Shorncliffe, near Folkestone; and if the sand at Hackington, near Canterbury, be a Tertiary marine sand, as I suppose it to be, it is probable that Sabella-tubes would occur in it. These tubes being held together only by glutinous matter, would not be very solid, and probably in a fossil state, would exhibit the puzzling conditions referred to by Mr. Brent. The sand in which they would occur would most probably be incoherent, and they are therefore very like to be exposed by wind action as stated.—Ed. Geol.]

The Earthquake at Mendoza.—Mendoza was a city containing twenty thousand souls, and presented all the appearance of a flourishing and increasing place. There remains to-day but a small chapel, the only building that withstood (perhaps owing to its foundation not being deep) the fearful earthquake which reduced the city in five minutes to a heap of ruins, under which were buried more than two-thirds of its population. Of those that were able to make their escape, some were seriously hurt, others lost their senses in the terror created by this awful phenomenon.

The earthquake declared itself on the 20th of March last, at half-past eight o'clock at night; the shock was so violent, the fall of the houses so rapid, that the inhabitants had not time to effect their escape, and were crushed to death.

The hour of the night in which the catastrophe took place, being a time when the city was in repose (for the inhabitants were an industrious race, of simple habits, and the town devoid of the amusements of large capitals) tended to increase the confusion and the number of victims.

The earth continued to open in several places, emitting violent streams of water, and then immediately closing up again.

A singular circumstance is related, namely, that this lamentable occurrence was predicted a month before by a distinguished French geologist, named Bravard, who, nevertheless, is believed to have perished in the ruins.

M. Bravard occasionally visited Mendoza, and wrote to a friend residing at Parana, that, having examined the city in a meteorological and geographical point of view, he had ascertained that it was situated between two extinct volcanos, and in the centre of a double current of electricity, from which he concluded that probably before ten years Mendoza would disappear.

Many distinguished men perished in this earthquake, among others, Martin Zapata, an orator of note.

ON THE CLYTIA LEACHII, A LONG-TAILED DECAPOD OF THE CHALK FORMATION. By PROF. REUSS. From the Transactions of the Imperial Academy, Vienna, vol. vi.—In the chalk-formation of Bohemia, next to the *Callianassa antiqua*, of Otto, which is found in quantities in the sandstones of north-eastern Bohemia, belonging to the upper chalk, the above-named species, *Clytia Leachii*, is the most numerous of the few crustaceans as yet found therein. This species seems to belong to the chalk beds known by the name of Pläner Kalk, which belong to the middle qauder-marls of Geinitz (Terrain Turonien of d'Orbigny). At least, as yet, I have never been able to discover them elsewhere.

Mantell, in his "Fossils of the South Downs," 1822, p. 221—3, pl. xxix., figs. 1—4, pl. xxx, figs. 1 and 2, pl. xxxi., figs. 1—4, figures and describes the earliest known specimens of this species, discovered in the white chalk of Lewes and Houghton in West Sussex, and gives it the name of *Astacus Leachii.*

Plate xxix, figs. 1—4, represent the most distinct specimens, wholly corresponding with the remains discovered in Bohemia: they are claws. Plate xxix, fig. 1, shows the claws of a very large specimen. Plate xxx., fig. 2, and Pl. xxxi., fig. 4, show the claw of each side opposite one another. Of the other limbs nothing distinct can be learnt from the drawing.

That fig. 5, of pl. xxix, really belongs to this species is improbable, on account of the crookedness of the claw.

Plate xxxi., figs. 1—4, represent the cephalothorax, which, however, seems to have been very incompletely preserved, and is also very indistinctly drawn, so that one cannot say with certainty whether it really belongs to the *Astacus Leachii.* Pl. xxxi., fig. 3, which shows most distinctly the crossline of the cephalothorax, most probably belongs, I fancy, to *Astacus Leachii.*

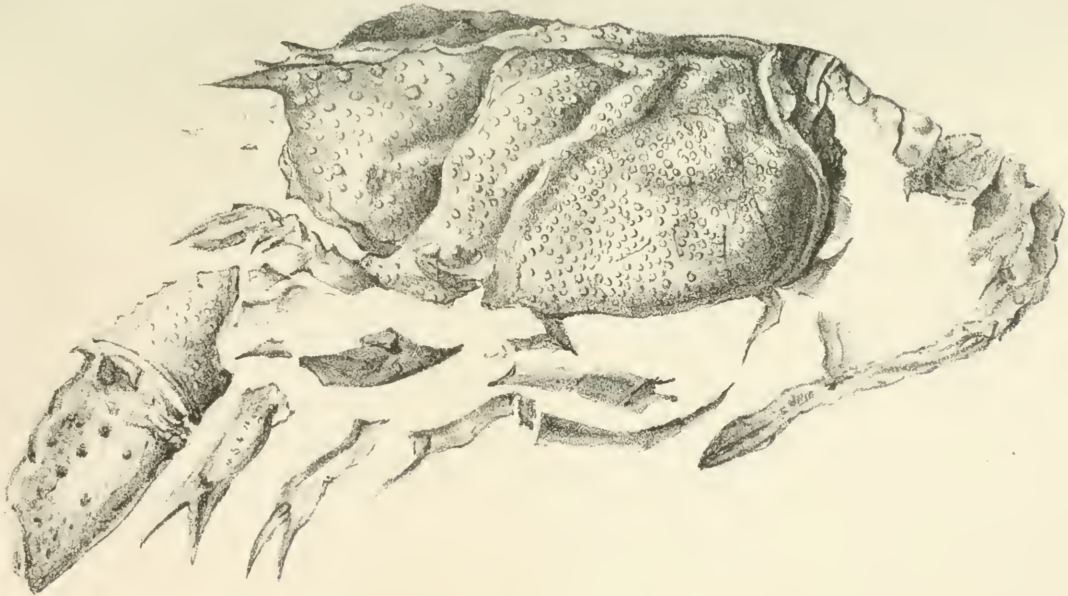
In fig. 2 of pl. xxxi. we have a line running lengthways, which is not to be seen in the much better preserved specimen of Bohemia; and it would seem, if the specimen represented really belong to the same species, that the line was accidental, and caused by the pressure to which it may have been subjected.

In Pl. 31, fig. 4, is represented one of the outside feelers, and a very indistinct claw of one of the forefeet. Nothing decided can be learnt from either.

Plate xxx, fig. 1, represents the very incomplete hinder end of the body, in which can be seen the three penultimate body-rings very much squeezed, and the inner tail-pins of the right side in pairs. Whether these really are derived from the *Astacus Leachii*, the total insulation of this part and the discovery of other Astacides in the same spot do not allow us to say with certainty.

Some time after Geinitz again discovered this crustacean in the Planer of Strehlen and Weinbohla, Saxony. and gave a description of a fragment from the former of these places, under the name given it by Mantell, (Characters of the Chalk Rocks of Saxe-Bohemia, p. 39, pl. ix., fig. 1). This fragment consists of a cephalothorax which has been subjected to much lateral pressure, and is incomplete in the front part, and a claw of large dimensions.

Romer in his work on the fossils of the chalk of Northern Germany (p 105), gives a short diagnosis; but without adding anything new or mentioning any



CLYTIA LEACHII. Reuss.

From the Chalk of Prague

fresh place of discovery. His description of the animals named by him *Glyphea Leachii*, is confined to the cephalathorax and the chelate limbs. He conjectures, however, that though the second pair of feet may have been provided with claws, the other three pair were not so. He moreover renders prominent the relationship between this animal and the *Clytia* of Meyer (New Species of Fossil Crabs, 1840). This relationship was acknowledged by me still more fully in my "Fossils of the Chalk Formation of Bohemia," so that I have found myself induced to connect this fossil with Meyer's species, under the name *Clytia Leachii.* I discovered it in the chalk of Kutschlin, near Bilin, and of Hundorf, near Toplitz, and also in the sandstone of Hradek and Tribitz. Those parts drawn and described by me (pl. vi., fig. 1 and pl. xlii., fig. 3), are the breast-shield (incomplete), feet with the great claws, fragments of walking feet, of masticators and a part of the edge of an outside feeler, the last three body-rings, and lastly some fragments of the tail.

I afterwards became acquainted with numerous fine remains from the White Mountains, near Prague, and the description of them forms the principal motive of this treatise.

Geinitz, in his work on the Quader-formation of Germany (1849, p. 7), names also the upper Quader-marls of Quedlinberg, as the place where the *Clytia Leachii* was found. As, however, I do not recognize by their appearance those remains as coming from the salt mines of that place, I am not convinced that they really belong to the species, and feel the less inclined to do so from the fact of Quenstedt in his Handbook of Paleontology giving a representation of a claw named by him as belonging to the *Astacus Leachii*, which does not in any way belong to the species, even if it belongs to an Astacide at all. Moreover, through the kindness of Dr. Geinitz I have received the claw of a real *Clytia Leachii*, from the Quader-marl, for examination. I learnt nothing more from the fact of its having been discovered, as Geinitz says in his work on the Quader of Germany, near Osterfeld and Dülmen.

Lastly, McCoy "On the Classification of some British Fossil Crustacea" in the Annals and Magazine of Natural History, 1849, p. 93, elevates the crustacean in question to the rank of an independent genus, distinguished from Meyer's *Clytia* by the superior size, the long spike of the breast-shield, toothed at the side, and with bunches of spines thereon, and on the claw-feet. From this character of the shell he names it *Enoploclytia*, and mentions two other kinds belonging to the same species, *E. Imagei*, McCoy, from the white chalk of Burwell and Maidstone; and *E. brevimani*, McCoy, from the lower chalk of Cherry Hinton in Cambridge.

In his short description of the characteristics of the species Enoploclytia he describes all the parts of the animal, with the exception of the claw-feet, feelers, and incomplete walking feet. These last gave rise to an erroneous conjecture on his part that all four pairs of feet end in a single claw.

Of the *E. Leachii*, however, he seems to know no other parts than those already described by Mantell. At any rate he does not mention any, and the character of the species seems to be only copied (as regards the after-part of the body) from the two other species, as it little accords with our species. But how McCoy could regard the *Enoploclytia Leachii*, except in relationship to the living species, the Galathea, is incomprehensible. He seems to have been misled in this case by the strong tooth-spike, the small hinder part of the body (which is not correct as regards the *E. Leachii*,) and the undivided outside lappets of the tail, without duly taking into consideration the other very different parts represented. Our species approaches much nearer to the Stomarus and Nephrops families, without entirely resembling either of them. I will afterwards more clearly prove this from given descriptions. My description treats

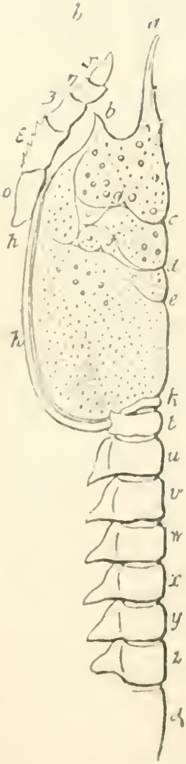


Fig. 1.—Ideal composition of the hitherto known parts of the Clytea Leachii.

Fig. 2.—The same seen sideways.

a, frontal spine of the Cephalothorax; *b*, orbital spines; *c*, nuchal furrow; *d*, branchial furrow; *e*, hinder forked furrow; *f*, shallow furrow passing from the branchial furrow towards the lateral protuberance (*h*) of the middle part of the cephalothorax; *g*, short furrows running from the nuchal furrow forward; *i*, side-piece of the middle division of the cephalothorax, which stretches forwards under the front portion; *k*, smooth border of the cephalothorax; *l*, long joint (femur) of the finger-foot; *m*, short joint (tibia) of the finger-foot; *n*, carpus; *o*, fixed finger of the pincers; *q*, *q′*, *q″*, *q‴*, walking feet; *r*, *r′*, cheld of the first two pairs of walking feet; *s*, *s′*, claw-like end-joint of the hinder two pairs of walking feet; *t*, first; *u*, second; *v*, third; *w*, fourth; *x*, fifth; *y*, sixth; *z*, seventh hinder body-rings.

α, undivided middle lappet of the swimming foot; β, outer antennæ; γ, hindermost masticatory foot; δ, first; ε, second; ζ, third; η, fourth; ι, claw-like last joint of the same.

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of numerous specimens, more or less perfect, received from three different localities, besides several details before unknown.

The most numerous come from the beds of the White Mountains, near Prague, and are now partly in the collection of Herr Von Sacher; partly in the collection of Herr J. Barrande (figs. 5, 6, 0); partly in the Mineral Cabinet of the Imperial University (fig. 1),) and partly in the Bohemian Museum (figs. 2—10). The specimens sketched in pl. xxxviii, from the beds of Strehlen in Saxony, were kindly lent me by Dr. Geinitz. The original of fig. 7, from the beds of Hundorf, near Teplitz, belong to the collection of Prince Lobkowitz in Bilin, from which, through the kindness of Herr Rubesch, I have repeatedly had it for examination.

On the Occurrence of Human Remains in Strata Contemporaneous with Extinct Animals.—When Cuvier, in the year 1824, was asked whether human remains had ever been discovered unquestionably of the same age as extinct animals, the cautious and philosophical character of the inductive mind of the great founder of palæontology was illustrated by his reply. He said "Not yet."

The object of the present communication is simply, by offering a brief sketch of the most remote examples of human remains in geological time, to place your general reader in a position to appreciate more correctly the recent generalizations of various naturalists as to the origin and genesis of the human race.

I shall avoid all the instances of the occurrence of the evidences of human art in ancient deposits, as the subject of the "celts" of Abbeville has been already satisfactorily treated by Mr. Mackie in this magazine, and as an able writer in the "Westminster Review" for October, 1860, has summarilized all the evidences of the contemporanity of man with the extinct elks, &c. I shall confine myself to the evidences of human bones in the prehistorical age of the world. I shall, however, treat with the greatest possible brevity those well-known instances which have been before the eyes of the public for many years, and lay most stress upon those newly-discovered facts which have recently attracted so much attention, even in general circles.

Many years ago, at Köstritz, in Upper Saxony, human bones were discovered in an undisturbed stratum eight feet below the remains of hyæna and rhinoceros. These specimens have been in the British Museum for many years, and consist of the parietal bone and part of the femur.

In America, Dr. Usher, of Mobile, has pleaded hard for the existence of a Mississippi backwoodsman fifty-seven thousand six hundred years ago, and we confess we can detect no flaw in his reasoning, however we may distrust his conclusions.

Dr. Dickeson, of Natchez, produces a human pelvis from the same geological age; but Sir Charles Lyell, with characteristic sagacity, doubts its legitimate association with the strata *in situ* at the foot of the cliffs.

Dr. Schmerling, whose magnificent *Ossements Fossiles des Environs de Liege* have thrown such light upon extinct carnivora, brings various instances of the occurrence of man's bones with extinct bears and elephants.

Dr. Lund, whose valuable palœontological researches are unfortunately inaccessible to many, on account of their being written in the Danish language, discovered human remains coupled with those of forty-four extinct animals at Minas Geraes, Brazil; and at a cave on the borders of Lake Lagsa Santa, he found bones of thirty different human individuals, together with the large extinct monkey, *Callithrix primævus*.

I shall pass over, completely, without comment, the Guadaloupe skeleton in the British Museum, as it certainly is not more than two hundred years old.

The earliest Celtic and Germanic skulls all unite in exhibiting a prominent supraciliary development, and a flattening of the frontal bones, so as to form a low type of cranial conformation, exhibiting somewhat an approximation to the negro races. The antiquity of these skulls is, however, of a far later date than that of the deposition of the carved flints in the valley of the Somme; and I have myself observed several Briton and early Saxon skulls fully equal in point of grade of development to the Greek or Caucasian skulls, idealized by Blumenbach as the summit of everything which could be predicated of virtue, intelligence, and beauty.

Prof. Owen has well pointed out the almost impossibility of laying down general rules respecting the skulls of the various races of mankind, and has declared, "I believe it would be rash to pronounce on the negro nature of any single skull, save among some of the lowest races of Western Africa." After such an authoritative decision, I hope that those palæontologists or geologists who draw conclusions in favour of the "Negro" or "Caucasian" nature of the skulls which they discover, will learn the lesson of caution, and give a more accurate and intelligible description of any human skulls which may be hereafter discovered in a semi-fossilized state.

The most important, because the most recent, and the most generally canvassed human relic is that which Dr. Schauffhausen, of Bonn, has recently published, with remarks by Mr. George Busk, F.R.S., in the "Natural History Review" for April 1861. According to this statement "in the early part of 1857, a human skeleton was discovered in a limestone cave in the Neanderthal, near Hochdal, between Düsseldorf and Elberfeld. The opinions of geologists in Germany seem united to corroborate Mr. Busk's conclusion, that there can be no doubt of the enormous antiquity of this skeleton (found under a deposit of four or five feet of mud on the floor of the cave), and of the probability of its having belonged to what has been termed the quaternary period. As, however, I know of no English geologist who has stepped forward to corroborate this theory, I hope that some of the many and intelligent readers of the "Geologist" may be led to consider the question.

To the paleontologist this skull offers a source of interest, inasmuch as it exhibits a singular character, hitherto supposed to have been peculiar to the highest apes. All those persons who have seen the gorilla in the British Museum, or who have read M. du Chaillu's descriptions of its habits, must have been struck with the large and prominent supraciliary ridge which makes a development from the frontal bone, and which gives to the animal that penthouse-like scowl over its eyes, and in which a crest of black prominent hairs is inserted, which greatly contributes to enhance the terrific appearance of the old male gorilla. This supraciliary ridge is characteristic of the genus Troglodytes; and in the chimpanzee it is also present, but to a less extent than in the gorilla. In this latter species a large amount of this elevation is due to the development of the space called by anatomists *frontal sinus*, which is a large cavity, divided into two portions by a perpendicular osseous partition, and lined with a continuation of the pituitary membrane, secreting the lubricating mucus discharged into the nose. This frontal sinus, Prof. Schauffhausen thinks, is the main cause of the production of the enormous supraciliary ridge in the Neanderthal cranium, as it is in the gorilla. Mr. George Busk dissents from this theory, and points out that in many recent crania of savage and barbarous men a considerable frontal elevation exists, in which no extraordinary expansion of the sinuses occur; and Sir William Hamilton (Metaphysics, ii. p. 125, asserts, "it is an error of the grossest, that the extent of the sinus is indicated by a ridge or crest, or blister in the external bony plate. Such a protuberance has no certain, or even probable, relation to the extent, depth, or even existence of any vacinity beneath." In the Papuan and Australian races of men, which approach nearest to the ape in their cranial conforma-

Front View

Side View

THE NEANDERTHAL SKULL

Fig. 1.

[illegible] II.—[illegible]
Gault, F[illegible]n.

Fig. 2.

[illegible]—Michelin.
[illegible]
[illegible]ction, British Museum.

[illegible] Del. [illegible] Woodward Direxit.

tion no frontal sinus whatever exists, whilst a rather considerable frontal elevation is exhibited; whilst in the chimpanzee in which a remarkable supraorbital development exists, no frontal sinuses have been discovered.

Professor Schauffhausen gives the measurement of a humerus, and radius, two femora, in a perfect condition, and of part of ulna, humerus, ilium, scapula, and ribs; and it appears from his statements, that they exhibit characters of a human race, far transcending the present as regards power of muscle, as indicated by the thickness and rugosity of the bones.

The presence and degree of development of the frontal sinus in the human and simian forms, are as follows:—

		Superciliary Arch.	Frontal Sinus.
1	European...............	Small	Large.
2	Papuan	Rather large	None.
3	Neanderthal skull ...	Large	?.
4	Gorilla	Very large	Large.
5	Chimpanzee...........	Large	None.

The above shows the difficulty of predicating the amount of the frontal sinus by the development of the supraciliary arch.

The author of the article in the "Westminster Review," which announces Dr. Schauffhaussen's discovery, describes his specimen as "the ruin of a solitary arch in an enormous bridge, which time has destroyed, and which may have connected the highest of animals with the lowest of men. But, even though the frontal bone of this remarkable skull constitutes a link intimately uniting the cranial conformation of the ancient human inhabitants of Europe with the simial, there is no evidence that in respect to size, the brain which that skull once contained approached more nearly to them than do the brains the Alfourian and lowest negro races.

It seems, therefore, that the party who have affirmed man's descent from a transmuted ape affect to find in the recently discovered human bones transitional links between the human and simian forms. The more cautious reasoner on the genesis of man, whilst affirming his origin by secondary law, gives due weight to those remarkable discrepancies between the structure of the lowest man and the structure of the highest ape, which would appear to auger for the human subclass a more exalted origin than the gorilla or *Dryopithecus*.

We find in the Neanderthal cranium a very fair development of brain, and in the general shape of the skull, (the supraciliary ridge apart), we find nothing which approaches to the gorilla. No interparietal crest, obliterating the sagittal suture, extends along the head; and although the hinder part of the skull is broken away, we cannot infer anything which approaches to an occipital or lambæoid crest. None of the other characters which so prominently differentiate the human from the simian sub-kingdoms are to be found in this ancient skull. It is not cerebrally inferior to the Papuan or Negro races.

Was this man from the Neanderthal of the same species as that which now dominates over the animal creation? Dr. Latham, in his Ethnological Aphorisms, says, "that all existing varieties of man may be referable to a single species, but there may be certain species, which have ceased to exist." Should this Neanderthal man have proved an intermediate species between the papuan and the gorilla, a great point of controversy would be gained by the transmutationists; but the failure of the proof which Dr. Schauffhaussen has brought forward, leaves the human species as far from the apes, as it was when the author, who founded the genus, placed it apart from the other primates.

It seems, therefore, irrefrably proved the the human species existed in Europe in the post-pliocene age, in as well as we can judge from the "celts" of Abbeville, a state of semibarbarism. However, sparse the population, he still found some enemy to contest with him the products of the forest, and the spoils of the chase. His vast solitude, compared with the present activity and teeming millions of modern Europe, reminds the contemplative observer of the beautiful exclamation of the patriotic esproneeda.

"Cuan solitaria la nacion que un dia Poblara inmensa gente!"

We have thus evidence of the existence of man-man, the highest-brained (archencephalate, Owen) individual of the highest sub-division of known Mammalia, in whose image the most specialized adaptation of structure to fixed purpose is superadded to the original type of created animal life, which great Archetype was conceived by a Divine Mind, millions of years prior to the advent of the human race.—I remain, Sir, your obedient servant, CHARLES CARTER BLAKE.

DESTRUCTION OF DEER BY COLD.—Keysler, in his "Travels in Wurtemburg" (1756), has this passage:—"At London, Paris, and other large cities, the number of inhabitants is calculated by the bill of mortality; in like manner a conjecture may be formed of the multitudes of deer in this country by considering that in one single hard winter above seven thousand of them expired." In a note he adds, "The two winters of 1731 and 1733 carried off above ten thousand head of deer and boars."

Is it not probable that the cold during the great mammalian age may at periods of unusual intensity have exercised a like influence in the destruction of life, and that to this cause may be attributed some of the great local accumulations in drift deposits which seem difficult to account for?

A SALT SPRING IN A COAL MINE.—Mr. Charlton, mining engineer and manager for the coal company, has communicated an unusual occurrence that was recently met with in the Dunkirk Coal Company's Astley Deep Pit, at Dukinfield. He states that in cutting a tunnel from the Black Mine Coal in a horizontal line towards the Cannel Mine, a beautiful spring of salt water or brine issued from a fracture in the rock, though remote from the trias and saliferous or salt bearing strata, and at the depth of 700 yards in the carboniferous measures. Mr. Charlton also states that in a careful analysis there were found in every 100 grains of the water—

Chloride of Sodium	4·50 grains.
Chloride of Calcium	0·37 ,,
Chloride of Magnesium	0·26 ,,
Total	5·13 grains.

Or about seven ounces, (nearly half a pound) of common salt per gallon. The specific gravity is 1·037, and the boiling point 214° Fahrenheit. Another remarkable fact stated is that a fine specimen of petroleum, containing naphtha or naphthalin floated on the surface, accompanied with a small quantity of carburetted hydrogen.

The pit alluded to is very deep, and the flow of brine from the spring discovered amounts to above 300 gallons in every 24 hours. The Cheshire deposits of rock-salt occur in the neighbourhood of Northwich, lying in patches along the valley of the River Weaver, in the Triassic formation. There are two beds—the upper one is reached at about 45 yards, and the lower at 80 yards from the surface. The brine or salt-springs which often issue from those deposits contain from three and a half to six and a half per cent. of salt, the saline property being undoubtedly derived from the solid masses of salt by subterranean waters.

A question naturally arises as to the origin of the saline spring at Dukinfield. Northwich is at least twenty-five miles distant from it, even as the crow flies. Dukinfield stands upon the Lower New Red Sandstone (Permian), which in that locality appears to be developed in an extraordinary degree as to its depth. At Macclesfield, which is distant about sixteen miles from Dukinfield, and is located on, or contiguous with the same coal-field—the mineral is reached at sixty yards below the surface.

Now the nearest point or boundary of the *true* saliferous strata (Keuper) of this county does not lie less than twenty miles from Dukinfield; and a solution of the problem may probably be found in the following suggestions:—

First, that water containing chloride of sodium in solution might possibly find its way from the above named strata to the newly discovered outlet in the Dukinfield mine,—for it is of sufficient depth to admit that possibility and even to drain the Trias in that part of Cheshire provided there were sufficient capacity or outlet for such drainage.—Again, there may be some adventitious deposits of saliferous shales, marls, or rock-salt, incorporated at a shorter distance than the Northwith rock-salt in the New Red strata, the solution of which by drainage reaches the pit.—Or, there may exist by a fortuitous circumstance or otherwise, deposits of rock-salt saliferous shales or marls in the superincumbent coal-bearing strata of the mine.—This latter, perhaps, is the most reasonable proposition. The question, however, is at present a purely theoretical, altnough a very interesting one. At all events the fact of a "Salt Spring in a Coal Mine" may be considered a geological phenomenon.—J. D. SAINTER. Macclesfield.

REVIEWS.

Memoir of Edward Forbes, F.R.S., late Regius Professor of Natural History in the University of Edinburgh. By George Wilson, M.D., F.R.S.E. (late Regius Professor of Technology at Edinburgh), and Archibald Geikie, F.R.S.E., F.G.S. of the Geological Survey. Macmillan and Co., London and Cambridge; Edmonston and Douglas, Edinburgh, 1861.

Painful it is indeed to review the life of one passed away into the regions of Futurity whom we had wished to number long amongst our valued friends. To us the name of Edward Forbes will be ever dear as that of one of our earliest and kindest encouragers in the paths of science, while by the world that name will ever be repeated with respect in memory of the genius and talent he brought to bear on the sciences of geology and natural history. The book before us has more than double interest. Not only is its subject matter of high interest as the personal history of a master mind, and that interest enhanced by the memoir being commenced by another eminent man of science, like Forbes, beloved for his amiable qualities and respected for his talent, but it has been continued and finished by a young author of no slight merit and of rising fame, Mr. Archibald Geikie. We all know Mr. Geikie's pretty "Story of a Boulder;" we know, too, the good work he has lately been doing with Murchison amongst the Scottish highlands; and we know, from other works and other labours, that Mr. Geikie can both write well and *work* well too. Forbes' Life by Wilson and Geikie must have many readers if the book stood alone on its literary merits; but when it has so wide-spread an interest as is still felt throughout our own land and abroad in the short and, so to speak, *unfinished* life of its amiable and accomplished subject, it is one that is sure to be generally read.

Whenever a great man dies, we all want to know something about him. Perhaps it is that we want to know how he became so much esteemed. Perhaps we silently, although it may be hopelessly, hope to be eminent too. Is it a lesson how to be so that we try to learn from the records of the lives of others? God grant it may, and that the pattern in every case may be as worthy as Forbes' of imitation.

"Edward Forbes was born in 1815, and died in 1854. The years of his life were thirty-nine: the years of his public labours as nearly as may be twenty-five. Into that quarter of a century he crowded more work than most men accomplish even when their span of days stretches beyond the allotted three score years and ten; and yet his work was but half done. He was cut off in the midst of his days, with his powers, so far as others could discern them, but partially evolved, and his purposes but half fulfilled."

The most beautiful of many others, "Douglas Bay lies embedded, like a crescent moon, in the south-west shore of the Isle of Man. The tip of either horn is a headland, the southern one crowned by a lighthouse. As it flits past, the crescent opens, and reveals all the objects which it defends from the open sea. In the centre of the bay a peculiarly picturesque tower of refuge stands on a reef, a beacon and shelter for the sailor. On the south-western curve of the crescent lies the town of Douglas, dear to us as the birthplace of Edward Forbes. Its foundations are laid in the delta of a small river, but it has climbed the heights encircling the bay, and spread itself gracefully over the gentle terraces and broad undulations which overlook the sea. The more stately eminences are occupied by stately castellated buildings; and behind all the lofty domes of Snaefell and the sister hills stand in array against the horizon. And, besides sand and fern, headland and haven, here and there, as the island passes before him, valleys opening on the sea allow the spectator to gaze far inland. The brooks that make them green are seen glittering in the sun, with the flicker of the leaves, whose shadows marble their waters. The white smoke of hidden cottages rises like a veil in front of the purple hills. The fragrance of wild flowers comes down the breezes, and the tinkling of sheep-bells, and the low murmurs of distant waterfalls. An island so varied and so beautiful was the befitting birthplace and cradle of one destined in future life to prove himself alike naturalist, artist, philosopher. While yet a child, the wild plants of its valleys had made him a botanist, and the spars and fossils of its shores had taught him something of geology. But the sea had the chief charm for him, and in the bays of Douglas and Ramsay he caught, whilst yet a youth, the first glimpse of those ocean revelations which have made him famous."

Edward Forbes was the second but eldest surviving child of Edward Forbes, Esq., of Oakhill and Cronkbane, near Douglas, by Jane, daughter and heiress of William Teare, Esq., of the Corvalla and Ballaby, Ballaugh, Isle of Man. His great grandfather, David Forbes, was implicated in the Jacobite troubles of 1745.

The immediate paternal ancestors of Edward Forbes were characterized by great activity and energy. Fond of travel, of society, and social pleasures, freehanded, and better at spending than at saving money. His grandfather was for some time at sea in command. One uncle died at Demerara; another in Surinam; a third travelled into the interior of Africa, and was last heard of some twenty or thirty years ago as king or sultan of some native African tribe. One of his own brothers perished by drowning in Australia; another was killed in America; a third, who resembles himself in genius, has seen many adventures in Norway and in South America. "A love of roaming," says his biographer, "certainly runs in the blood of the Manx Forbeses, and in none of them was it stronger than in Edward, whose happiest hours were spent in travelling in strange lands and dredging in unfathomed seas." His mother, by the universal testimony of all, was a singularly gentle, amiable, and pious woman, devoted to her children, and beloved by rich and poor. The childhood of Edward Forbes was a happy one. His father's affairs for a long season were prosperous, and his mother also possessed property in her own right, which, by Manx law, was under her own control. He remained at his father's house till 1831, when he had reached his sixteenth year, and it was thought time to select a profession for him. His mother wished him to be a clergyman; his father a physician. His own wish was to be a naturalist, but, with the consent of all parties, a compromise, curiously illustrative of his versatility, was entered into, and he was sent to London to become a painter. The compromise failed in its purpose; but he did not again make the Isle of Man his residence, except at vacation intervals.

In the volume before us we are next passed on through his false start as an artist, his residence in London, his student life in Edinburgh, his abandonment of medicine as a profession, and then we come to the time when he adopted natural history as a permanent vocation. When he returned to the Isle of Man in 1832, he spent the three autumn months of the year in diligent work. He had brought back from Edinburgh greatly enlarged views of natural history, and a greatly increased acquaintance with its recorded facts. Furnished by his training at the University with a knowledge of the means by which great naturalists had observed nature, he discovered new riches every day in the territory of Man, and he formed the resolution to write a work on the entire natural history of the Island, including some reference to its civil history, and a full account of its antiquities. In the end he partially carried out this intention. His "Malacologia Monensis" was published at Edinburgh in 1838. Four years later he contributed to Mr. Cumming's work, "Notes on the Flora of the Isle of Man, and a chapter on its Natural History and Geology." He did not live to achieve a complete account of the Isle of Man, but the uncompleted investigations which he made in reference to its physical features, and especially his dredgings along its coasts, furnished the starting points for some of the widest generalizations with which he enriched the whole science of natural history. The doctrine of Specific Centres of Distribution of Plants and Animals, if not suggested to him, was at least in his apprehension strikingly illustrated and confirmed by the characters of the Fauna and Flora of his native island as compared with those of Great Britain and France on the one hand and of Ireland on the other. To take an example which has long been of popular and even superstitious interest, the absence of poisonous reptiles from Ireland and the Isle of Man was explicable on the hypothesis that they originated on the continent, and spreading from their centre of birth there, reached England in the course of their western divergence, when Great Britain formed part of the now adjacent mainland. Before, however, they had travelled to Ireland, or even to Man, these had become islands, and could no longer be reached. On the other hand, the great Elk (*Cervus Megaceros*), whose bones are found both in Ireland and Man, may be assumed to have crossed from Europe to both at a time when the Irish sea and the British Channel were occupied by land which has since disappeared. His doctrine also of zones of submarine life differing in character according to the depth of the sea in which they showed themselves, has been referred to by writers as first adopted by him in the Mediterranean; but it is quite certain that it dawned upon him during these early dredgings along his native shores, and it was reduced to writing years before he visited the Ægean.

In November, 1832, he re-commenced the study of medicine, which was not finally abandoned until 1836, and after that, his uninterrupted vocation was that of a naturalist. It would have been strange if he had been a zealous medical student, and in later years he deprecated all compliment to himself as a model student. His note-books of that period are full of those grotesque but pointed drawings which he was ever so noted for making. "Here and there are copies of diagrams shown by the lecturer, such as the convulsed body of a sufferer from lock-jaw, a bandaged or ulcerated limb, or the branches of an important artery. Mingled with these, however, and quite overpowering them, are likenesses of professors, lecturers, and students; Dr. Knox, who appears in many attitudes, being the favourite subject of portraiture; sketches of shells, flowers, crystals, imitations of children's drawings, and fantastic imaginary figures innumerable. Whimsically various though these drawings are, a certain medical tone prevails among them. A pedantic doctor flourishes a stethoscope. A grim anatomist 'opens' a body in an unheard-of fashion. A sick man makes wry faces over a physic bottle. Skulls abound. Skulls laughing, weeping, wearing spectacles, looking wise, looking foolish, displaying every human passion. Skeletons are not less abundant, and in the most lively attitudes; gesticulating, dancing in couples, fencing, perambulating; more like living men and women who had adopted the Rev. Sidney Smith's recipe against very hot weather, and for coolness' sake had undressed to their bones, than the grim relics of the dead, at home only in the grave."

In 1836, the death of his mother took away one strong motive for taking a medical degree. He knew that his elevation to the rank and title of physician would greatly please her, and he loved her too well to grudge the effort to give her that pleasure. For five years he had nominally been training himself to win an honorary title, and just when it was within his grasp, he flung away his weapon and folded his arms.

"To most but himself he seemed to have made shipwreck of his genius. He had tried two professions and failed. Art disowned him; medicine disowned him. To be a virtuoso man of the world appeared the goal of his ambition.

"So it seemed, but so it was not. His genius had reached its nadir, and though none knew it less than himself, half its course was spent. It was from this moment daily to mount higher and higher above the visible horizon, till it reached, and for too brief a season shone forth from, the zenith.

"When he parted from Fine Art, he uttered a good bye, not a farewell, and in token thereof he took his pencil with him. When he parted from Medicine, he asked to retain his scalpel as a memorial of the art of dissection which she had taught him. With these two simple tools alternately in his hands, and as a guide and interpreter of both, the microscope at his eye, he had such a triad of things as pleased his fancy and occupied all his faculties."

His biographers now give us accounts of the student clubs he formed, and of his vacation rambles, with details of his first years as a professed naturalist. We have then his trip to the Ægean Sea; after which his connection with the Geological Survey began, and continued until his election to the chair of Natural History at Edinburgh the city where two and twenty years before he had been a student of medicine.

"Measured by what he actually did in natural history, his name cannot be placed where some of his warm friends would inscribe it, along with those of Aristotle, Linnæus, Cuvier, Owen, and Goodsir. But it would be unjust so to estimate him. It must be remembered that he passed away ere reaching his prime, and he must be tried, not merely by what in his short life time he did himself, but by the ideas which, scattered by him broadcast over the world, have sprung up and are bearing fruit in many lands. He did more, perhaps, than any other man of his day to spread abroad a love for natural history; more undoubtedly than any one of his contemporaries to indicate how natural history and geology must be woven together. The name of Edward Forbes will go down to posterity inseparably linked with the history of palæontology, as one of the greatest naturalists that ever strove to bring his knowledge of the living world to elucidate the physical and organic changes of the past history of the earth.

"He attained this high eminence not as a solitary worker. In nothing was his career more marked than in the power he possessed of interesting others in his field of labour. His broad philosophical spirit enabled him to appreciate the researches of the chemist and the physicist, and in return he drew their sympathy with him into his own domain. In bearing down all jealousy and envy among his fellow naturalists, and enlisting their active co-operation in the common cause, he stood forth conspicuous among the scientific men of his time; and this he accomplished not so much by the weight of his authority as by the influence of his manly, true-hearted nature. On no phase of the life of Edward Forbes does it seem needful to lay greater stress than on this; for on no other ground can we account for the great influence which he exercised, not in scientific circles only, but in society at large. It was not his mental powers, great though these were, nor his vast knowledge of those branches of science which he made his especial study, that gained him the love and respect of all men, but a simple, kindly heart that knew no selfishness, and embraced in its wide and generous sympathy all that was honourable and good."

Handbook for Travellers in North Wales. London: John Murray, 1861.

Of Dr. Bevan's Handbook for South Wales we have already spoken in terms of praise, and we are not less disposed to accord to the present work a less mead of just enconium. The Handbook of North Wales contains not only information for the general traveller or excursionist, but also useful matter for the geologist. Within the last two years the district has been made more accessible to the tourist by the construction of new railways, which, although not so numerous as in the southern portion of Wales, have already been, and are likely to be still more, instrumental in developing the resources of the country. Dr. Bevan arranges his book very much in the same way as his former one, commencing with an introduction, in which he first describes the physical features; then devoting a section to its geology; after which, commerce and manufactures, antiquities, communications, and a glossary of Welch words (the last highly necessary for the stranger Englishman). The doctor then devotes another section to "Points of Interest for the Geologist," and one to the "Comparative Heights of Mountains," concluding the introduction with "Chief Places of Interest" and "Skeleton Routes." Then of course follows the main mass of the hand-book, giving the routes and the descriptions of the places which travellers are likely to visit. Everything worth seeing or knowing, from the curious Elizabethan pigeon-house at Llanengrad to the manner of raising the famous Menai Bridge, is most curtly and concisely jotted down by our indefatigable and pleasant author.

The Past and Present Life of the Globe, being a Sketch in Outline of the World's Life System. By David Page, F.G.S. London and Edinburgh: Wm. Blackwood & Sons, 1861.

THERE is little doubt that the heading of the papers on popular geology, which we commenced in this Magazine, have been, at least, suggestive of titles to more than one author; if, indeed they have not been suggestive of the subject matters of some books. We are not jealous of, nor sorry for this. If we had desired the credit of doing the work ourselves, we should have kept our own by our own activity. We have not abandoned that series, although fate has denied us the opportunities of carrying them on rapidly. We hope shortly to be able to go on again with them, and then, from time to time, we shall have the means of giving our own views on matters now under discussion by geologists. Whether Mr. Page has caught an idea or two from the "GEOLOGIST" is of little moment; and if he has, he is quite welcome to them for the good use he has turned them to. In the charming little book before us, he has under the title of "The Past and Present Life of the Globe," discussed in very moderate terms the great question of the day introduced by Darwin's very memorable book—the uniform development of creation. He has not professedly done this, but in reality, this is what he has done; and the book is well worthy of the student's attention. The introductory chapter commences with a peroration on the interest attaching to the study of the Past in natural as in human history: fossils or petrified remains of plants and animals are, of course, regarded as the alphabet-letters of the great book of creation, by which its interesting chapters are to be read. Then Mr. Page brings his readers to the Present. He describes broadly the great groups and characteristic features of its fauna and flora and their co-adaptations. He thinks properly that before we can right compare the Past Life, of which these (fossil) relics give evidence, with that which now peoples the globe, we must glance at the conditions under which plants and animals at present exist, and know something of their nature and the functions they have to perform. "We can only reason," he says, "respecting the Past from our knowledge of the Present; and the more intimate our acquaintance with the various phases of existing nature, the sounder our deductions relating to those which have long since passed away. We say the *various phases of existing nature* for the plants and animals that people the surface of any given latitude may differ in character from those entombed in the strata beneath, and the organisms in the several formations below may now find their nearest analogies in the flora and fauna by distant and different regions. If we are familiar, however, with the general conditions under which plants and animals now live and flourish, and if we can establish a relationship between those existing and those long since extinct, then we can recall the conditions under which the latter grew and flourished, and map out the geography and climate of the primeval world, as the geographer now maps out the areas of sea and land, and depicts the various races of life, the belts of sterility and exuberance, and the creative centres from which peculiar families have emanated to perform their functions in the great economy of nature." And so, on these principles Mr. Page takes us through the flora and fauna of the present age, beginning with plants and the conditions under which they exist, their typical forms and characters, their primal plan and patterns, the systematic arrangement of their forms, and the persistency of plan in time past. Animal life is now taken up, and its typical forms and their functions, its primal plan and patterns, the systemmatic arrangement of its forms, and the identity of plan in time past are considered, and then we are led to the co-adaptation of plants and animals in one great life-scheme.

Some might think the treatment of these subjects slightly antiquated, but everyone is not yet embued with Darwinian doctrines; and indeed of those that are there are many not honest enough, or too timid to confess their faith. No doubt it is safer and more prudent to go in the highway of the world, and to follow the ordinary traffic, even in science.

For our part, we are rather erratic, and being good pedestrians, we jump over a fence, step over a style, take footpaths in preference to turnpikes, and have more than once lost ourselves in a wood. It is true by so doing we have suffered some inconveniences, we could not always find an *auberge* when we wanted refreshment, we have more than once been attacked by thieves, been benighted, and have met with other mishaps; but then we have often been rewarded with such glorious views from the hill top, such picturesque scenes in dell and valley, that the advantages of freshness, truth and beauty, have far outbalanced all evils, and we are as ready as ever to take the chance of a deviation, as if we knew not of attendant inconveniences.

Mr. Page takes the more legitimate roads, and will consequently avoid many of the scrapes into which we might have got, had we attempted what he has done.

"In attempting this (botanical) arrangement, numerous varied and complex as vegetable life may at first sight appear, the botanist has happily a few great fixed principles in nature to guide him; *type* and *order* run unswervingly throughout the whole: and though the Creator might easily have constructed each species after its own type, and rendered plants as varied in their individual forms, as they are numerically abundant, yet He has thought fit to restrict himself, as it were, to a few types, and humanly speaking, like a skilful inventor to produce an almost endless variety from the co-adaption of a few simple elements and complexity of design by the elimination of a few primal patterns. As innumerable hues can be produced from a few primitive colours, as endless strains of music flow from the touches of a few simple words, or as the ideas of all times and nations can be expressed by the combinations of some twenty or thirty letter-sounds; so in the structure of animals and plants every variety of form, every conceivable adaptation of structure, proceeds from the modification of a few elementary forms and types in nature. Without this uniformity of plan and design. the study of nature by man's limited faculties would have been impossible. In summing up the co-adaptations of the flora and fauna, these are the views which the author takes: "Perfect as the existing flora and fauna may appear each in its own proper line, they are only constituent portions of a greater life-system bound together by numerous co-adaptations and adjustments. As each is adapted to, as well as dependent on, external conditions, so both are dependent on one another, and as at present constituted, neither could possibly enjoy a separate existence."

Having laid before his readers a sketch of the Present Life of the Globe, its plants and animals; the causes which effect their growth; the conditions which govern their geographical distribution; their ordinal characters; and the functions they are destined to perform in the economy of creation, our author turns to the extinct—the geological record. The chronology or the arrangement of the world's Past into rock-formations, and life-periods is the first subject; the continuity of natural law, the second; and these are followed by a disquisition on palæontology, the problems it has to resolve, its progress and prospects. The more detailed considerations of the geological subject are divided into the Far Past, the Middle Past, the Recent; the last includes the Terteary period, the age of great mammals, existing forms and distribution of life, general and local extinctions, MAN-prehistoric and historic, and the mutations of the human race.

Mr. Page then lays down "The Law;" and this, of course, must be regarded as the principle chapter of the book; and some of the subjects treated are amongst the grandest that can occupy the mind of man.

The grand law of nature, Mr. Page sets forth as ORDER. So it is. In tracing this order, the first subject would naturally be the dawn of life. While admitting that, as we descend into the rocky crust of our planet, we reach a stage in the sub-Silurian metamorphic rocks, where life does not seem to have existed, Mr. Page will not argue for the restriction of life to the Cambrian period; but he considers we must have something more certain than fanciful analogies to carry our convictions any distance beyond these strata. He thinks too, that the evidence of fossil life is greatly in favour of the belief that in this stage "we have reached, or all but reached, the dawn of organized existence." All but reached! Sometimes in our erratic way, we are tempted to ask, Yes! but What is *under* the granite? And some day this will not seem so mad a question as it does now. It would be slow work to hunt over the old Gneiss, so the hunting is not done. Someday, some painstaking local geologist will do it, and then perhaps life-forms will be found down there.

However, we now let Mr. Page speak for himself.

"As we ascend in the geological scale, we find life increasing and spreading stage by stage into newer and higher forms; and as we descend, we find it decreasing and narrowing to simpler and lowlier aspects; and surely we are justified in the inference, that in the few scattered organisms of Cambria we have all but attained the ultimate limits of vitality. Were matter and life co-dependent, we might reasonably argue for their co-existence; but as neither can exist without the manifestation of vitality, and as life appears only in subordination to the material forces, so the one may have existed for ages without necessarily implying the presence of the other. And further, if untold epochs have been spent in the evolution of life from its earliest to its present aspects, it is equally conceivable that cycle after cycle may have rolled by in the elimination of the purely material structure of the world before it seemed to the Divine Mind a fitting habitat for the plants and animals with which He had destined to adorn its surface." * * * "Starting from this point, we may fairly inquire, how, and by what means this earth became the "procreant cradle" of organized existences? * * * Science cannot even indicate the line of inquiry; our highest philosophy is the humble recognition of the fact; the chemist and the physiologist may resolve the vital organism into cells and granules, and nuclei, but here their efforts stop: they cannot endow these cells and germs with life. * * * "This present ignorance, however, can form no plea for the absence of future effort; everything unknown is not to be held as a miracle."

The next subject is the uniformity of type and pattern in past and present time; "the plants and animals of the ancient world, though differing widely in genera and species were neither 'abnormal' nor 'monstrous;' but both in point of size and form and structural adaptations were very much alike to those of the present day. So much so indeed, that could we recall them to mingle in the busy scenes of life around us, they would neither startle us by their appearance, nor alarm us by their habits, one whit more than the existing flora and fauna of distant and different regions. The great types remain the same throughout all time and space; and though the modifications have been innumerable; these modifications, even in their agreement, have never amounted to an obliteration of any important primal distinction. Acrogenous, endogenous, and exogenous, radiate, articulate, molluscan, vertebrate range side by side as distinctly now, each within its own typical idea, as when they first clothed the land, and peopled the waters." * * * "As to *function;* earth and water ever seem to have had their varied tenantry. * * In the mutual dependencies of existence, demand has ever pressed on supply, decay trodden closely in the wake of reproduction, and suffering been commensurate with enjoyment. An ideal Cosmos of painless beatitude is a dream and a delusion."

* * * "With regard to distribution * * * from the beginning different regions have been peopled, partly by identical, and partly by representative species."

Admitting that external conditions *have never been uniform*, Mr. Page goes on to the *introduction of new life-forms*. Here the question naturally arises, as each geological epoch is characterized by its own peculiar plants and animals, "Whether there are independant creations, or whether there is in nature some law of development by which, during the lapse of ages, and under the change of physical conditions, the lower may not be developed into the higher species, the simpler into the more complex?" Mr. Page thinks "geology is not in a position to solve the problem of vital gradation and progress." We think differently from that gentleman, at least to this extent, that geology has already collected considerable materials indicating the reply which, to our minds, undoubtedly it ultimately will give. Of course it is a delicate point to deal with, and the highway here is a far easier road than the faintly-tracked path we might be inclined to pursue. We do not hint even that Mr. Page is not sincere in what he writes, but his logic is not quite as good on this topic as it might be. Why we do not pretend to say, but certain it is that modern geologists do not always—cannot, or will not, perhaps—write logically. Perhaps they think one way and write the other in deference to popular opinion; if so, we are not surprised at their logic being bad; but whatever the cause, as a rule they are eminently *not* good logicians. We do not understand how Mr. Page can logically insist on "new creations" of organized forms on one page, and on the opposite repudiate the terms "extinction" and "creation" as applied to the races of organic beings of geological periods. "We must not," he tells us, "fall into the common but mistaken notion that the flora and fauna of one period were utterly extinguished before the commencement of the next. There are no such extinctions and re-creations in nature."

These reflections lead our author to the "Development Hypothesis," which in this present review is a subject that *we* will leave alone. As we will also the "acceptance of vital hypothesis." The pages, however, which we skip may be read with profit and interest. We pass over also the "Advent of Man," as the details of flint-implements and other items of this topic have been, and are being, fully dealt with in the pages of this magazine. Neither will we go into other questions which Mr. Page eloquently discusses —"Time Geological," "Course of Creation," "Creation still in Progress," "Duration of Species," "Term of the Human Race," "Influence of Man on the Future," "Progression or Succession," although we give their titles to show what interesting subjects he has selected, but we pass at once to the last of his work before he writes its conclusion—"Onward and Upward," and in the sentiment of which we fully concur.

"Ignorant of the teachings of geology and the great progression it unfolds, mankind have hitherto regarded the scheme of life as culminating and terminating with their own race. All or nearly all the hopes that give colouring to their thoughts and direction to their actions proceed from this belief, though in strictest science the belief itself rests on no logical foundation. It is true, one of our highest biological authorities (Professor Agassiz) 'thinks it can be shown by anatomical evidence, that man is not only the last and highest among the living beings of the present period, but that he is the last term of a series, beyond which there is no material progress possible in accordance with the plan upon which the whole animal kingdom is constructed; and that the only improvement we can look for upon earth for the future, must consist in the development of man's intellectual and moral faculties.' This, however, is a mere plausible assertion; the 'anatomical evidence' is not produced; and every one cognisant of the history of man knows that intellectual and moral development has ever been restricted to the newer and advancing varieties of our race. It is true that man at present stands the crowning form of vital existence, but the facts of the past give no countenance to the believe that he shall remain the crowning form in future epochs. From its dawn until now the great evolution of life has been ever upward, geologically speaking (and be it borne in mind we are treating the question solely from a geological standpoint), shall it not continue to be upward still? We see no symptom of decay either in the physical or vital forces of nature; and so long as these forces continue to operate, mutation ard progress must inevitably follow. Man's own history, physical and moral, has been one of incessant change and progress. The features of different races, their mental qualities, civil systems, and religious beliefs, have all less or more partaken of this mutation; and the difference that now subsists between the most intellectual, city-dwelling, machine-making Anglo-Saxons and the men of the old flint-implements and bone-caves may be infinitesimally small, when compared with that which may exist between the noblest living nations and races yet to be evoked. Unless science has altogether misinterpreted the past, and the course of Creation as unfolded by geology be no better than a delusion, the future must transcend the present, as the present transcends that which has gone before it. Man present cannot possibly be man future. Noble as he may appear in his highest aspects, it were to limit creative power and arrest its progress to aver that man may not be superseded by another form still nobler and more divine. Physiologically, we cannot suppose that the homologies of the vertebrate skeleton have been exhausted in the structural adaptations of man: psychologically, we dare not presume against the correlation of a nobler intellect with a higher organisation. On the contrary, in these ascending forms the divine idea of moral perfection, though unconceivably unattainable by created existences, may be nearly and more nearly approached, and stage by stage the loftiest and holiest aspirations of the present may become the realisations of the future. To speculations such as these, though lying fairly in the way of geological inquiry, science can do little more than merely indicate the line of reasoning; and if they shall be thought to involve any question as to man's religious beliefs and his hopes of a future life, on this point also science is mute, and defers with humility to the teachings of a higher philosophy."

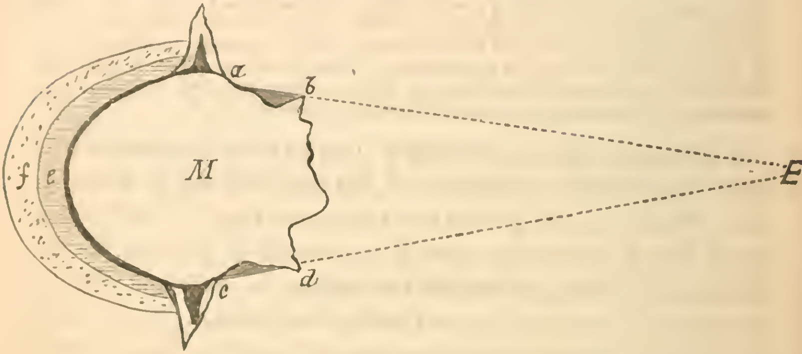
Long as this review may appear, there is much more we should have liked to have extracted, much more we should have liked to have said. Excellent and much appreciated as Mr. Page's other elementary books are, this is the chastest, the most popular, and the best of anything he has yet produced for the student of our glorious science.

THE GEOLOGIST.

OCTOBER, 1861.

WHAT HAS BECOME OF THE LUNAR SEAS?

Was there a deluge? It is not to advocate any new reconciliation theory we ask this question; it is not to urge afresh some supposed contact with a comet (if we have just passed through the tail of one, at most the harm we got was a few heavy showers); nor is it to show that periodical inundations or oceanic overwhelmings of each hemisphere—north and south—alternately take place every few thousand years. Probably they do. But neither fifty deluges, nor ten thousand, nor a hundred thousand, would make one deluge—A DELUGE. Our purpose then is, to inquire whether there might not have been, once upon a time, a physical natural cause for *a* deluge. As the crime of the sinner is often the cause of the amendment of the law, so the bold speculator, breaking out from the trammels of established dicta and the fashionable propriety of a safe reserve, may, as Macdougal Stuart in his daring ride across Australia opened out a luxuriant country where geographers predicted a sandy desert, likewise break in upon glorious fields before unknown. We have so many safe respectabilities in geology that an erratic notion now and then cannot do much harm, if it do no good. When we look up to the moon, what do we see? Great ocean cavities and *no water in them.* It is of no use to say it is ALL gathered up on the other side. We cannot believe *that.* The moon always presents one side to our earth, and, therefore, her ocean waters ought to be drawn up on this, and not the other side. We do not mean to say there is no water there, because all the water and nearly all the air *which is left* on the moon, some



astronomers tell us, is there, kept back by the mountains. Thus —the *features* of our moon being very highly exaggerated, of course,— that is to say, the water (shaded in the diagram) on the invisible face of the moon, and the atmosphere (dotted) above, do not exceed in height the level of the lowest valley in the mountain-ridges which keep them back. There *may* be a little water remaining in the ocean-cavities on the side we see (a little air also), retained by the angular position of other ridges, which *keep them back* (as at *a b*, *c d*). Such are the views some take, while all map out great spaces and call them seas,—*Mare Nubium*, *Mare Humorum*, *Mare Tranquillitatis*, *Mare Serenetatis*, *Mare Imbrium*, and *Oceanus Procellarum*. But they do not tell us what *has become of the water* that once *was* in them. "Gone to the other side." Gone against attraction?—No. Will Professor Phillips, who is doing Lunar Geology as well as Terrestrial, tell us? Will any Oxford scholar tell us—divine or scientific?

When Mr. Airy lectured at the great Manchester Hall, a few weeks since, he said—

"The following diagrams (Nos. 2 and 3) are by Professor Plantamore, who went from Geneva to the east coast of Spain. As the moon entered on the right,

Fig. 2.

Fig. 3.

three of these rays occurred on the left; and when the moon was leaving the sun's disc, rays were seen on the right. This seemed to show that the appearance was produced by a cloud or cloudy atmosphere between us and the moon. In our atmosphere there were sixty or eighty miles of darkness all round, and these appearances could not be formed by refraction there. Is there, then, an atmosphere all the way to the moon? There is nothing else to explain them, as far as I know, and I think this does. Polarization supports it also. When light is not reflected, it is vulgar white light; but when reflected from the surface of a transparent medium, it puts on that modification known as polarization. When, therefore, we see it polarized, we have strong reason to think that the light has been reflected, and hence, by something like an atmosphere between the earth and the moon."*

A little chink will let in much light. Is this a chink to let some in? It is the only support for a long-retained, and perhaps it may be visionary, idea. When some one praised the Astronomer Royal, in the section of the British Association meeting over which he presided, for the boldness of his views on terrestrial magnetism, he justly said, "When he believed he was right, he could *boldly* state his views; but he could be bolder still, *he could retract them when he found them wrong.*" We do not like to risk our reputation, but we can be bold enough to speculate if we think there be but a grain of truth in our day-dreams. Beyond doubt, modern geologists do not countenance the idea of a single or particular deluge, much less an universal one, mountain-high, all over the globe. Even divines have sought to limit and restrict the Noachian deluge to certain geographical areas, and otherwise to modify or do away with the universality spoken of in the Holy Writ. Unlike the genesis of man, it is a subject we can discuss without offence to any religious prejudices. It is a question purely of tradition—not of inspiration at all—and we may discuss it as an historical fact, or as a physical fact, with the utmost freedom and licence.

Take it first, then, as a TRADITION. The flood of Noah, the flood of Deucalion—every nation has its *tradition* of a flood. There are few traditions, surely, without *some* foundation in truth; and while it would be impracticable to reconcile a universal deluge overwhelming the peaks even of the mountains some few thousand years ago, with the present physical aspect of our globe, and the geographical distribution of animal life, or to find any geological phenomena that would give countenance to it at all, the antiquity which the discovery of flint-implements, and other relics, and even bones, in Pleistocene strata, and in turbaries, have given to man, entitle us to extend

* An excellent illustrated report of Mr. Airy's lecture is given in the *London Review*, No. 64, for September, 1861.

greatly backward in time the epochs of remarkable events, of which the traditions have reached us from a *very remote* antiquity indeed. It is even possible that such traditions may extend back to the Pliocene period, in which seemingly, if not before, the age of man began. But we leave this subject alone, and return to the question—*What has become of the waters of the moon?* The ocean-cavities, if they were once filled, must have been emptied. What emptied them? We know that year by year the moon gets nearer to us; it may be only half an inch, and astronomers even dispute whether it is more than a quarter; but nearer, we believe, it does come. We know also that such changes are said to correct themselves, but we cannot say there is not a residual balance in favour of approach. There is good reason to consider that nothing in the whole universe is stable, although the changes are so slowly grand that centuries of observation are insufficient to prove their rate. Still we may believe the moon has come nearer the earth. If it comes nearer, it has once been farther off; no doubt it has—very much farther off; and *then* it was it had its atmosphere and its oceans. Then the great *Oceanus Procellarum* was a rolling sea, and the *Mare Serenitatis* lay glittering under the golden streaks of our earth's bright beams, and clouds floated in, and storms disturbed the encircling atmosphere. But when the moon, gradually diminishing her distance, came sufficiently within the influence of the earth's attraction, did its superior gravitation draw off her moist atmosphere towards its own, and make a roadway of thin air, along which clouds of the most highly rarified watery vapours might travel earthwards? With the diminished pressure, consequent on the partial loss of atmosphere, the water on the moon's proximate surface would more and more quickly evaporate; for just as water boils on one of our mountain peaks with less heat, as the pressure of our air diminishes, or as warm water boils in a vacuum, so would the reduction of atmospheric pressure by the earth's attraction of her atmosphere, and the continued loss of vapour cause a most *rapid* evaporation of her seas, and *clouds of highly rarified water* would roll along the aerial way, and mingle with those in our skies. The waters of the moon might thus be transported to our globe, and carried by strong and sweeping currents all around, while the lunar vapours, in condensing, would fall in torrential rains over the whole face of the earth. Whether the transference would be in "forty days and forty nights," or not, we do not pretend to say. Sudden and rapid might be that of the last remaining portions of the moon's oceans, when the atmospheric pressure was reduced to its minimum, and *torrential rains* might be thus produced on our earth—not a total submergence of the land beneath one uniform sea of waters, but such a condition of inundations and torrents as might well be regarded as a *universal flood*.

Mr. Downes has shown, with good reason, that comets may be frozen-up worlds of water-ice and solidified air, the effect of the intense cold of the vastly distant space to which in their excentric courses they reach out, and where the sun can seem no bigger than a point or a tiny twinkling star. Comets, therefore, might bring watery vapour and air to our atmosphere; but comets are not one, but many. Every year or every century might, if comets were the cause, witness a deluge. What might have happened once could happen twice or fifty times, and comets hence can be no more regarded as *the* cause of AN universal deluge than the regular cyclical oscillations of the earth's poles in 20,000 years. The transference of the moon's water to the earth could happen but once. The torrential nature of the final rains of such an occurrence might well produce on the terror-stricken minds of men, or the imaginative mind of the historian, the idea of the "windows of heaven being opened, and the fountains of the deep broken up." If Mr. Airy be right, that an atmosphere extends now to the moon, we can scarcely consider that our own atmosphere extends as a regular enveloping sphere up to the moon's surface, because if it did so, one would think the moon would wrap herself up in a mantle of it; but rather should we not presume that the moon raises by her attraction up to herself the apex of a vast atmospheric tide? and if so, the roadway of the lunar rains is still extant.

Nor do we wish to assign any particular period to the supposed transference of the moon's waters to the earth. It might as well have happened in the carboniferous age as in the tertiary or recent. It might have occupied millions of years, and have influenced for ages the meteorological conditions of our atmosphere. But if geology points specially to any particular time we think it does so to the Loëss and loam-period, when the deposits seem to give evidence of a very long-continued rain-fall. If this be so, and it were due to the cause that we have been considering, it would bring the period within the era of man, and the tradition of a flood may have a deep-seated origin of truth in remotest antiquity. Hence the only reason why we have connected the subject of the Deluge with the almost purely hypothetical speculation we have been guilty of. In the later tertiary deposits there seems almost everywhere evidence of the torrential action of water, and apparently tumultuous accumulation. The rain-fall of lunar vapours might have produced such numerous simultaneous local floods and inundations as to give comparatively an appearance of universality to the phenomena, and the final rains might have been rapid and cataclysmal.

Knowing as we do how readily men scoff at "far-fetched notions," it has required some amount of courage to put even the simple question—What has become of the water of the moon? Doubtless the moon had once ocean and air; if so, What has become of them? is a question not to be avoided by the geologist in the consideration of the past, because if those waters have not been amalgamated with the earthy and metallic substances of the moon, nor driven off into space, nor attracted to the sun, which are not likely, their transference must have taken place under the natural laws of gravitation to the earth. When this was, mathematicians or astronomers may work out; and geologists may confirm their results from the recording pages of the earth's crust.

We beg, however, these remarks may be viewed as they are intended—as a *speculation.* We do not attempt to prove that the attraction of the earth would have been sufficient to draw away the water of the moon in the form of highly rarified vapour. The idea is not propounded as a theory. We know if not all, at least far too many, of the difficulties to be opposed to even a general torrential rain, to see our way clearly to surmount some of them. One thing, however, is certain, there are waterless ocean-cavities on the moon, and the question is well worth asking, or considering, Where have their waters gone to?

CORRESPONDENCE.

To the Editor of the Geologist.

SIR,—When a subject of so much importance as the antiquity of the human race is being discussed, there is a liability to the production of fallacious facts, as well as the possibility of "true facts" being pressed beyond their legitimate value.

A correspondent has furnished you with some particulars concerning the discovery of a human skull in the valley of the Trent, near Newark—a very different locality from the vale of Belvoir.

I am of opinion that some caution is necessary before this discovery can be taken in evidence upon the subject in support of which it is brought forward. There are facts associated with the locality which, I conceive, do not support the apparent testimony—that the skull in question belonged to an individual who lived in the age of animals now extinct. The position in which it was discovered—so near to the river Trent—would give a degree of suspicion to its being a genuine witness ; besides, its being so near to a bend in the river would make its value additionally questionable. The horns of deer, and bones of extinct animals, with which it was found, do not supply a sufficient reason in this particular instance for its being produced in evidence of a high antiquity.

Any one who is familiar with the geological phenomena of the Trent Valle would regard with considerable doubt the claims which this skull should have in bearing testimony upon so important a question, because an apparently undisturbed condition of the drift could not be relied upon as a safe criterion by which to judge of the antiquity of its animal remains, in localities near to the present channel of the river. The Trent, in various parts of the valley, is ever changing its course, especially at the curves. In the course of a few centuries, therefore, it is possible the stream might deviate considerably from its original channel. This fact has been observed in several instances. In one example, a few miles from the place at which the remains alluded to were discovered, the gradual erosion of the land from one side at a bend in the river, and an equivalent deposition on the opposite margin, has continued until several acres have been transferred from one side of the river to the other, within the memory of living individuals. The river, moreover, does not continue at the same depth at any particular place; places which were once fordable are now too deep to pass over, and *vice versâ*.

If human remains were discovered at a depth of twenty-five feet in these drift gravels, over which it was known the river had passed in recent times, it is certain they could not supply any satisfactory evidence of a high antiquity.

The diagram at p. 351 represents the locality of the discovery. The sharpness of the curve in the river would undoubtedly in a few centuries cause the stream at this place to deviate more or less from its original course. This skull may, therefore, have been in the first instance at the bottom of the river with the bones of animals and horns of deer washed out from the drift gravels, and as the stream gradually removed from the channel in which it then flowed, they would be covered by its deposits. In course of time the river would have removed to a distance from its former bed in which the remains were found.

The association of pottery with the other relics in so limited a space as fifteen feet would seem to indicate a depression in the bed of the river, into which they would be collected by the current.

The river's deposition of sand and silt would also assume that natural form which would have the appearance of an undisturbed stratification, because it had been formed by natural causes.

If those who have inspected the locality have fully estimated these facts, it may be the discovery is as valuable as your correspondent appears to consider it.

I am, dear Sir, yours respectfully,

Nottingham, 13*th Sept.*, 1861. J. H. W.

THE CRADLEY PTERASPIDES.

Dear Sir,—In answer to your correspondent of last month, who signs himself "Malleus," I merely state again that when I visited the quarry at Cradley, in June last, there was a large heap of stone in blocks of about a foot to a foot and a half square, which had been worked out of the quarry, and that most of these blocks when carefully examined, contained three or four good specimens (some more) of *P. rostratus*. I had in my possession one piece of sandstone from Cradley half a foot square, in which were imbedded five Pteraspides and one Cephalaspis. Part of this specimen is now in the British Museum. I should not have called my specimens *P. rostratus* unless I had had good authority for so doing. As your correspondent inquires as to what or whose it is, I beg to inform the "poor ignoramus," as he styles himself, that I have shown all my specimens of Pteraspis to Professor Huxley, who has had others from the same locality under examination, and it was upon his authority that I called them *P. rostratus* and not *Lewisii* or *Lloydii*. In conclusion, I would say with your correspondent, "Do not, young geologist, turn aside from Cradley, but repair thither," &c., and mind to provide thyself with *the largest* bag thou canst lay thine hands on.

I remain, dear Sir, yours truly,

8, *Savile-row.* E. R. Lankester.

THE DARWINIAN THEORY.

Sir,—In replying to Lieut. Hutton's article on the Development Theory of Mr. Darwin, I understood him to advocate the Development Theory as usually propounded. I find, however, from his explanation in your number for July, that such is not the case; that he claims for his theory what the theory claims for the various forms of life, namely, the ability in the "struggle for life"—and a hard struggle this "theory" has had for *its* life!—to modify itself according to circumstances. And hence arises the fact that what seemed "shadows" to him possessed all the characteristics of reality to me. The "Development Theory," as I knew it before Lieut. Hutton published his views concerning it, is thus epitomized by Professor Oken ("Elements of Physio-Philosophy"—quoted by Hugh Miller in "Footprints of the Creator"):—"No organism has been created of larger size than an infusorial point. No organism is, nor ever has been, created which is not microscopic. Whatever is larger has not been created but developed. Man has not been created but developed." Do these sentences contain Lieut. Hutton's idea of the Development Theory?

As thus laid down the Development Theory says, "Man was not created but developed." The Bible says, "God *created man in his own image*." Again, the new "variation" of the theory, as "developed" by Lieut. Hutton, says, "Man" was developed from the brute until "the time was come that he was fitted to receive his mental and moral powers"—when *can* a brute be "fitted" to receive a responsible soul?—and that *then* "they were given him by a special interposition of the same power that created (developed?) all things." That is to say, one night the "man" Adam lay down to sleep a brute, with the irrational mind, brutish propensities, and irresponsible nature of a brute, and awoke the next morning a man, with the God like intellect and untainted holiness of unfallen humanity! This is "development" with a vengeance; and the faith that can swallow this camel of transmutation need never strain at the gnat of creation. To me it seems very little different from what the advocates of creation by direct act claim, at least so far as man is concerned, for we can neither say that Adam the man was the same individual with Adam the brute, nor yet that the one was a development of the other. Therefore it is evident, from Lieut. Hutton's own admission, that the "Theory of Development" fails, in the case of man, to account for the various forms of organic life.

But let us pursue this admission to another of its results. While it is undeniable that the superior mental powers of man pre-eminently distinguish him above every other creature, it is equally undeniable that most, if not all, of the other forms of life possess their various degrees of mental power, and that they are not more distinguished by their peculiarities of form and structure than by their varied degrees of intelligence and sagacity. Now, either the higher natures are developments of the lower, or they are not. If they are mere developments, *why* may we not regard the nature of man as a development too? What special reasons are there for supposing the nature of man to be a creation, while we regard the varied and distinctive natures of the other animals as mere developments? We perceive in the old proverb, "Necessity is the mother of invention," the popular recognition of the fact that circumstances have a certain modifying effect upon the intellect of man, and that, too, in cases where, in all probability, they would fail to exercise any modifying effect whatever upon the mental powers of the brute. If, therefore, the developing power of circumstances acts in certain cases with even greater effect upon the man than upon the brute, *why* may we not suppose that these modifying causes might act during an almost infinite succession of ages and through an almost endless chain of being, and the accumulated result be the mind of man as we now find it?

Further, if mind of any degree *can* be developed, I certainly see no greater difficulty in supposing that an animal, under the pressure of circumstances, might modify its mental powers (as in fact is done daily in education, both in man and many of the lower animals), than in supposing that it might acquire a new member or a new faculty. If, for example, the mussel *can* develope into the fish, as Oken says it can, *why* may not the nature of the mussel develope into the nature of the fish? Or, if the fish *can* develope into the land animal, *why* may not the nature of the fish develope into the nature of the land animal? Or, finally, if the brute *can* develope into the man, *why* may not the nature of the brute develope into the nature of the man? From a careful perusal of Lieutenant Hutton's article and explanation, it appears to me that he supposes the various natures of the inferior animals to be mere developments, the higher of the lower; but how he can at the same time consistently maintain that the nature of man was "given him by special" act of creational power, I confess I cannot make out. Perhaps he found himself in one of the "dilemmas" he speaks of, and wished to harmonize his theory with the facts before him. If, however, I misapprehend his "Theory," and if, in reality, he means to assert that mind cannot *in any case* be developed, then in effect the "Theory of development" becomes the "Theory of creation," for a continuous series of "special interpositions" is assumed, and the idea of development becomes a new and very comprehensive idea indeed.

But to return for a moment to the theological aspect of this theory, Lieutenant Hutton says, that "man" was developed from some inferior animal (he does not know which), but that his "mental and moral powers," that is, his soul, were bestowed upon him at the proper time by a "special" act of creation. The Bible says (Gen. i. 26, 27; ii. 7, &c.) that God *created* man both body and soul. I am aware of the use which Lieutenant Hutton makes of the word "created," but I reject that use of it in this place as evidently inappropriate. I have not as yet seen the pamphlet by Dr. Asa Gray, but I *have* read my Bible, and whether I interpret it aright or Lieutenant Hutton, I leave your readers to decide. For a further discussion of the theological bearings of the Development Theory, I must refer your readers to Hugh Miller's "Footprints of the Creator," a work containing some very good arguments on the subject.

I have already occupied more of your space than I originally intended, and consequently feel loath to trespass further; still I cannot close my letter without a remark or two on the actual position of geology with reference to this theory. I will endeavour, however, to be very brief; and if in consequence of this enforced brevity, my arguments or illustrations should seem to any incomplete or inconclusive, I trust they will ascribe such defects to their true cause, and not to any uncertainty in the teachings of geology, which, to me at least, are plain and unmistakeable.

In my former letter, inserted in your number for June, I quoted from Darwin the statement that, if his theory were true, then before the deposition of the lowest Silurian strata there elapsed periods of time "probably longer than the whole interval from the Silurian age to the present day," during which "the world swarmed with living creatures;" and I put to Lieutenant Hutton the question which had already been put to Mr. Darwin—"What has become of the records of these vast primordial periods?" In reply, Lieutenant Hutton simply refers me to his very elaborate picture of the manifold shortcomings of geology—shortcomings which, if they really exist to the extent he wishes to make out, must go a great way towards invalidating nearly the whole of the facts of Palæontology. For example, what reliance can be placed upon the teachings of a science any one of whose *known* facts may be successfully denied by a reference to some other of its *supposed and unknown* facts, and of which it is asserted, by even its own cultivators, that we can at the best only hope to obtain a few fragments of its latter half? We shall return again to the subject of these alleged defects in the geological records; meantime be it remembered that these "primordial periods" are altogether hypothetical—that they are assumed in direct opposition to the opinion of the most eminent geologists —that they are admitted by Darwin himself to be "quite unknown," and that they are assumed by the advocates of the Development Theory solely because the existence of their theory requires it. The dictum of Johnson strikes me as peculiarly applicable to such ingenious speculators. "He who will determine against that which he knows, because there may be something which he knows not—he who will set hypothetical possibility against acknowledged certainty, is not to be admitted among reasonable beings."

Again, to test the "theory" still further. "What," asks Hugh Miller, "in order to establish its truth, or even to render it some degree probable, ought to be the geological evidence regarding it? The reply seems obvious. In the first place, the earlier fossils ought to be *very small in size;* in the second, *very low in organization*" ("Footprints of the Creator," p. 21). Every student of geology knows how completely the *facts* of geology contradict the "theory" on these points. "The earlier fossils" of *every formation*, from the lowest to the highest, are, as is well known, neither "very small in size," nor "very low in organization." The lowest found fossils of each form of life are not fœtal or imperfect; when they make their first appearance they are always found fully formed, and perfect in their organization. Nay more, so far from the fossils of the different formations appearing imperfect in form or organization on their first appearance, and then exhibiting a gradually-increasing perfection of form and organization as we ascend from the lower to the higher beds (as they ought to do according to the "theory"), we find that in many respects the contrary is actually the case—that "the magnates of each race walk first," and that if geology furnishes no "*reasons* for disbelieving the theory" of development, it furnishes many *undoubted facts* in favour of an opposite theory of degradation. Many of these facts are very ably set forth in Hugh Miller's "Footprints of the Creator," an excellent work, and to which I again refer the reader. I leave to Lieutenant Hutton the task of harmonizing the *negative evidence* which he considers geology to furnish in support of his Theory of Development with the *positive* evidence adduced by Hugh Miller in support of his theory of degradation.

I am aware that in opposition to these statements Lieut. Hutton will refer me to that part of his article in which he describes the imperfection of the geological record, and assumes that we have not yet reached, and that we ought not to expect ever to reach, the horizon of any form of life. But to this I reply—first, by asking him if he means to oppose to acknowledged fact hypothetical probability, and if so, I refer him to my quotation from Johnson. But I reply still further, that this argument *admitted to its fullest extent*, is very far from being conclusive. Admitted that we are not to assume that the lowest found fossils of any form of life coincide with the dawn of that particular organism, still if it is an admitted fact that that form of life makes its first appearance *perfect and fully formed and comparatively high in its organization*, the "Development Theory" plainly asks too much of us when it asks us to believe that this form could have gone on developing itself from some other form, during perhaps "hundreds of thousands of years," until it had assumed its most perfect form, *and no record whatever of its condition during all this enormous period of time be preserved.* And this too, be it remembered, not merely in the case of one particular form of life, *but of all the forms of life!* If the records of geology are really as imperfect as this amounts to, their testimony is certainly of very little value either for or against the development or any other theory.

But this leads me to remark, that I have cause to believe that the geological records are not nearly so imperfect, nor the results of what imperfection actually does exist nearly so important, as some naturalists to suit certain purposes attempt to make it appear.

The readers of Owen will no doubt remember the paragraphs on the distribution of the Mammalia in his "Palæontology," in which he asserts the value of even the negative portions of geological evidence. Objecting to the "conjecture that the mammalian class may have been as richly represented in primary and more ancient secondary as in tertiary times, could we but get remains of the terrestrial fauna of the continents," he insists that the negative evidence furnished by the total absence of mammalian remains from the primary, and "the scanty and dubious" traces of them in the secondary beds, is sufficient to carry conviction to the unbiassed mind that this class did not exist at all during primary times, and only began to exist in secondary times, and says that, "to the mind that will not accept such conclusion, the stratified oolitic rocks must cease to be trustworthy records of the condition of life on the earth at this period." The applicability of this to the case in hand is obvious.

Again, as we descend into the crust of the earth, the animal kingdom gradually loses its present high and diversified character—first, one great class and then another disappears from the stage of existence, until as we approach the lowest of the fossiliferous beds, the evidences of former life become not only confined to the lowest forms, but gradually more and more rare, and finally they cease altogether. This is the lowest zone of ancient life, and *below it no trace of organic life is found.* And this too, be it remembered, in situations not at all ill-calculated to preserve any forms of life which might have been committed to their charge, many of these rocks being in fact much less metamorphosed than many others higher up in the geological series, which actually do retain impressions of the organisms originally buried in them. From these facts the conclusion naturally follows, that if we have not in these lowest fossiliferous strata actually reached the dawn of life on the earth, we have approached sufficiently near to warrant our forming an opinion respecting it, and to make the expectation of further discoveries in this direction all but hopeless.

Here again we find additional proof of the trustworthiness of the geological records. In them we find an almost complete history of the progress of life on the earth from its dawn millions of ages ago down to the present day. In them we find breaks certainly—breaks sufficient to show us that our history of life on the earth, full as it undoubtedly is, is not perfect; and to stimulate the diligent inquirer with the hope of occasionally adding a new link to the chain—but as certainly we find nothing in them to warrant the idea of such breaks as the Development Theory demands—breaks of thousands of centuries, at least as often as the commencement of each geological formation, and probably of much more frequent occurrence.

On these and many other grounds, therefore, I arrive at the conclusion that the facts of geology do *not* support the Theory of Development, and in concluding this communication, I would urge upon your readers the duty of a thorough and impartial examination of the bearings of geology upon this "theory" before its claims are admitted or even temporized with. It is evidently, as Professor Owen expresses it, a "chance aim of human fancy, unchecked and unguided by observed facts;" and further he says respecting it, that "observation of the effects of any of the hypothetical transmuting influences in changing any known species into another has not yet been recorded."

The "inconsistencies and absurdities" Lieut. Hutton speaks of are merely imaginary. For example, I believed, and still believe, that if I could show one of the links of the supposed chain of development to be defective, the whole theory would fail *as a theory attempting to account for the conditions of life on the earth,* because insufficient to account for the phenomena of life. Well, did I not show the defectiveness of the supposed link between man and the brute? And did not Lieut. Hutton acknowledge this defect by attempting to patch it up with an act of "special interposition?" Did he not, therefore, by this act acknowledge that his theory was, by itself, insufficient to explain the conditions of life? Then let Lieut. Hutton show *where* the "inconsistency" or "absurdity" of my assertion lies, and having done *that,* let him next explain his own inconsistency in introducing creational acts into a "Theory of Development."

His other objections are about equally well founded, and as my communication is already far too lengthy, I therefore pass them over in silence.

I am, &c.,

Glossop, July 26th. T. GRINDLEY.

FOREIGN CORRESPONDENCE.

General Considerations on Meteorites. By Director W. Haidinger. (Vienna Imperial Academy of Sciences, March 14, 1861.)

The specimen of the meteorite which fell May 19, 1858, at Kakowa (Banat), and which Count Coronini, then governor of the province, transmitted to the Imperial Geological Institute at Vienna, and which afterwards was transferred to the Imperial Museum, gave the first impulsion to a renewed study of these highly interesting substances, and to the completion of the collection of meteorites in the Imperial Museum, by exchange and otherwise. By this way specimens were obtained from Europe (Tula, St. Denis-Westram, Trenzano), from India (Allahabad, Assam, Pegu, Segowlee, Shalka), and from North America (Nebraska), together with valuable information concerning these phenomena, while MM. Haidinger and Reichenbach made them a subject of theoretical investigation, the results of which were published in the "Proceedings of the Vienna Academy," and in several German periodicals. Numerous and partly accurate as the statements on this matter are, the establishment of a complete theory of meteorites, and of the phenomena attending them, would still be premature.

Several of Director Haidinger's theoretical views have been lately stated independently by Professor Lawrence Smith, of Louisville, Kentucky; others have met with more or less positive contradiction.

Two objects offer themselves for scientific consideration. 1. The phenomena connected with the appearance of meteorites within the boundaries of our globe. 2. The consequences to be deduced from the study of the metallic and stony meteorites in themselves, especially as to their more or less crystalline structure.

The meteor observed by Dr. Schettczyk on November 28, 1859, at Strakonitz (Bohemia), appeared at first in the form of a star, and gradually increased to the size of a fiery ball, which at last exploded without (at least so far as hitherto known) being followed by the fall of any solid substance. At New Concord, Ohio, on May 1, 1860, a similar phenomenon was very accurately observed; but no mention is made of its first appearance in the shape of a star. The resistance opposed to the igneous globes by the atmospheric air, compressed during the whole course of their rapid passage, is particularly worth consideration. A twisting hurricane moves at the rate of 92 English miles per hour (134·72 feet, Vienna measure, in one second); a point of our globe's surface under the equator, under perfect calm and horizontal atmospheric pressure of above 1800 Vienna pounds per square-foot (while the same pressure in the above mentioned hurricane does not exceed 32·81 pounds), accomplishes its rotatory movement at the rate of 1464·7 feet per second; while in the same time, the meteors pass generally through a space between 4 and 23 and more miles; the pressure, at an average velocity of seven miles per second, being 22 atmospheres per square-foot. Benzenberg has already pointed out the analogy of this process with the apparatus for lighting matches by sudden and violent compression of air; and indeed the passage of a body through air at such a rate cannot be conceived without an enormous compression, and consequent development of heat and light. The air is forced on every side out of the meteor's orbit, in directions perpendicular to it, and must round itself in a spherical or ovoid manner from behind the rapidly progressing meteor. As Professor Smith supposes, the sound is not a consequence of explosion, but the clash produced by the air suddenly filling up the vacuum left by the meteor behind it, and renewed every moment as it continues its career. Dr. Haidinger and Professor Smith, with many other naturalists, agree in the supposition that meteorites are fragments of larger solids pre-existing in the cosmic spaces; the hypothesis of their existing originally in a state of igneous fusion being in open contradiction to the generally accepted hypothesis of an extremely low temperature (100° C.) of these spaces. The tufaceous aspect of meteorites seems rather to indicate an originally pulverulent state, in which crystallogenetic forces were called into activity, and modified or counterbalanced by external circumstances, in a mode analogous to the formation of the sphærosideritic septaria occurring in argillaceous strata. The first effect of pressure from without must have been the formation of a solid, superficial crust, during whose complete solidification lateral pressure, and the descending movement of heavier particles, would call into action thermal, electrical, and chemical influences. A similar process going on within the external crust may possibly occasion real explosions. The chapter on meteorites has been most ably and profoundly treated by M. E. E. Schmidt ("Lehrbuch der Meteorologie"), G. Karsten ("Algemeine Encyclopædie der Physik," Leipzig, 1860), and F. C. Naumann ("Lehrbuch der Geognosie.")

DEEP SINKING FOR COAL IN THE WYRE FOREST COAL-FIELD.

By George E. Roberts.

Mention is made by Mr. Hull, F.G.S., in the second edition of his useful work on the coal-fields of England, of a deep sinking for coal on the estate of the Arley Pottery and Fire-brick Company, situated at Shatterford, five miles north of Bewdley. This work, though unfortunately ending in failure, and leading to the abandonment of the enterprise, deserves a prominent position in the annals of coal-mining, chiefly because the section obtained may be regarded as an index to nearly the whole of the coal measures of the forest of Wyre. Through the courtesy of Mr. John M. Fellows, manager of works to the late company, I am enabled to place on record the particulars of the shaft-sinking. To illustrate it, I have sketched the geological construction of the district for three miles in a line north-west to south-east, adding a section due north and south of the near-lying anticline of Trimpley, where the upper tilestones crop out. While the work of sinking was in progress, I obtained daily intelligence either through visits or by communications from Mr. Fellows, to whose obliging conduct in giving me every facility for scientific investigation I am greatly indebted.

The specimens obtained from each bed were particularly examined by me, and the fire-clays, which, from their number formed an important part of the series, were of a highly interesting character. The fossils obtained do not require special notice, no new fern being met with, and the Sigillariæ, &c., being few in number and badly preserved. These in every case lay prostrated in the strata, and appeared to have been drifted.

PARTICULARS OF SHAFT-SINKINGS AT ARLEY WORKS, NEAR BEWDLEY, STAFFORDSHIRE, OCTOBER 30, 1860.

		Yards.	Feet.	Inches	Yards.	Feet.	Inches
1	Soil	—	1	—	—	—	—
2	Clay	1	2	—	2	—	—
3	Rock binds	1	2	—	3	2	—
4	Blue	5	—		8	2	—
5	Coal	—	1	2	9	—	2
6	Mottled red ground...	9	1	9	18	1	11
7	Nearly same	4	—	—	22	1	11
8	Light, having appearance of fire-clay ...	9	—	6	31	2	5
9	Mottled pink ground	7	—	6	38	2	11
10	Mottled with yellow ground	4	—	—	42	2	11
11	Coarse fire-clay	3	—	—	45	2	11
12	Blue binds	1	1	6	47	1	5
13	Thin coal		—	2	47	1	7
14	Blue binds, dark	1	—	—	48	1	7
15	Light blue binds	12	—	—	60	1	7
16	Dark shale, nearly black	—	1	6	61	—	1
17	Coal	—	1	7	61	1	8
18	Inferior fire-clay	1	1	6	63	—	2
19	Blue binds	6	—	—	69	—	2
20	Light rock	16	1	6	85	1	8
21	Coal	—	1	—	85	2	8
22	Blue binds	8	—	—	93	2	8
23	Coal	—	—	6	93	3	2
24	Thill	—	—	6	93	3	8
25	Coal	—	—	6	94	1	2
26	Brown and white rock	28	1	6	122	2	8
27	Conglomerate	2	—	—	124	2	8
28	White rock binds	6	—	—	130	2	8
29	Limestone balls	—	1	—	131	—	8
30	Dirt or soft thill	1	2	—	132	2	8
31	Red and yellow mottled ground	4	—	—	136	2	8

		Yards.	Feet.	Inches	Yards.	Feet.	Inches
32	Same	7	1	6	144	1	2
33	Blue binds	4	1	6	148	2	8
34	Cakes of ironstone	—	—	3	148	2	11
35	Coal	—	1	8	149	1	7
36	Fire clay	1	—	—	150	1	7
37	Dark binds	5	—	—	155	1	7
38	Nearly same	12	—	—	167	1	7
39	Thin rock, brown	—	1	6	168	—	1
40	Dark binds	6	—	—	174	—	1
41	Roof clay	1	—	—	175	—	1
42	Roof coal	—	—	9	175	—	10
43	Holing clay	—	1	6	175	2	4
44	Coal	—	2	8	176	2	—

The above sinkings were made about the year 1850.

The following were continued from the above coal in the year 1859, and finished in 1860:—

		Yards.	Feet.	Inches	Yards.	Feet.	Inches
3	Fire clay	1	2	—	178	1	—
4	Mottled ground, with ironstone pins ...	3	—	—	181	1	—
5	Strong grey rock	4	—	—	185	1	—
6	Hard conglomerate rock	2	—	—	187	1	—
7	Mottled ground	2	2	6	190	—	6
8	Strong grey pebbly rock	2	—	—	192	—	6
9	Red, blue, and green grounds (mottled) ...	2	—	—	194	—	6
10	Strong bluish rock (gritty)	2	2	—	196	2	6
11	Rock binds	—	1	6	197	1	—
12	Mottled ground	—	1	—	197	2	—
13	Grey rock	3	2	—	201	1	—
14	Strong mottled ground	2	2	—	204	—	—
15	Mild bluish rock	—	2	6	204	2	6
16	Blue and red binds	—	1	—	205	—	6
17	Mild blue rock	—	2	6	206	—	—
18	Strong mottled ground	1	—	—	207	—	—
19	Blue and red rock	1	—	6	208	—	6
20	Red marl	—	—	6	208	1	—
21	Blue rock binds	—	1	—	208	2	—
22	Red binds and red and grey rock (strong) ...	1	2	—	210	1	—
23	Blue rock ditto ...	—	2	—	211	—	—
24	Red and blue binds	—	2	—	211	2	—
25	Red and green marly ground	—	1	—	212	—	—
26	Strong light blue limestone-looking rock ...	1	—	—	213	—	—
27	Red and blue binds	—	2	4	213	2	4
28	Red and green parting	—	—	8	214	—	—
29	Light mottled ground and strong blue rock ...	2	—	—	216	—	—
30	Red and green rock	1	2	6	217	2	6
31	Blue and grey rock	—	2	—	218	1	6
32	Red and blue binds	—	1	6	219	—	—
33	Ditto	1	1	—	220	1	—

		Yards.	Feet.	Inches	Yards.	Feet.	Inches
34	Red, blue, and strong white mottled ground	1	—	6	221	1	6
35	Strong grey rock	—	1	6	222	—	—
36	Red and blue and brown and blue mottled ground	2	2	—	224	2	—
37	Light-coloured marl	5	2	—	230	1	—
38	Red and blue rock	1	1	—	231	2	—
39	Blue and red marl (rocky)	4	—	—	235	2	—
40	Red rock	—	2	—	236	1	—
41	Blue rock	2	1	—	238	2	—
42	Grey, red, and blue strong rocky ground ...	4	2	—	243	1	—
43	Blue rock (mingled with red at top)	1	2	—	245	—	—
44	Blue binds " " " ...	1	—	—	246	—	—
45	Coarse conglomerate rock...	5	—	—	251	—	—
46	Green and brown rock	—	1	6	251	1	6
47	Blue and red ground	1	1	—	252	2	6
48	Bastard fire-clay	1	2	—	254	1	6
49	Red and blue rock	1	—	6	255	2	—
50	Strong blue rock	3	1	—	259	—	—
51	Red and blue rock	1	2	6	260	2	6
52	Blue and red rock binds	2	—	—	262	2	6
53	Grey conglomerate rock	7	—	—	269	2	6
54	Black and pink ground	—	1	8	270	1	2
55	Coarse fire-clay	1	1	—	271	2	2
56	Red and blue rocky grounds	2	2	4	274	1	6
57	Blue and red ditto	1	2	—	276	—	6
58	Coarse fire-clay	—	2	—	276	2	6
59	Blue and red and dark shaly ground	1	—	6	278	—	—
60	Blue rock	1	—	6	279	—	6
61	Red and pink rock	—	1	6	279	2	—
62	Blue rock and dark binds	2	—	—	281	2	—
63	Dark binds, shaly, with impression of fossil plants	—	1	6	282	—	6
64	Grey rock	1	1	6	283	2	—
65	Dark binds	1	2	—	285	1	—
66	Hard light rock	1	—	—	286	1	—
67	Blue and red rock	1	1	—	287	2	—
68	Red and blue mottled ground	1	2	—	289	1	—
69	Strong red and blue ground	1	—	—	290	1	—
70	Light-coloured shale	—	2		291	—	—
71	Dark ditto	—	2	—	291	2	—
72	Strong common fire-clay	—	2	—	292	1	—
73	Dark rock	—	2	6	293	—	6
74	Coarse rock ... [stone and bits of coal	—	—	6	293	1	—
75	Dark grey and blue rock, mingled with pins of iron-	1	2	—	295	—	—
76	Conglomerate rock	2	2	—	297	2	—
77	Rock mingled with black shale	1	1	6	299	—	6
78	Light-coloured fire-clay rock	1	—	—	300	—	6
79	Brown and red coarse rock	2	1	—	302	1	6
80	Red and blue ground	3	—	6	305	2	—
81	Blue rock	1	—	3	306	2	3
82	Black bat	—	—	9	307	—	—
83	Fire-clay, mingled with pins of ironstone ...	2	—	6	309	—	6
84	Hard mottled rock	3	1	—	312	1	6
85	Dark yellow marl	—	2	—	313	—	6
86	Dark and red marl	—	2	6	314	—	—
87	Fire-clay (good)	1	—	—	315	—	—
88	Dark fire-clay rock	—	1	—	315	1	—

		Yards.	Feet.	Inches	Yards.	Feet.	Inches
89	Dark red and blue rock	—	2	—	316	—	—
90	Strong grey rock	5	—	—	321	—	—
91	Blue binds	—	2	—	321	2	—
92	Dark gritty and shaly rock	2	1	—	324	—	—
93	Dark binds mingled with red	2	—	—	326	—	—
94	Fire-clay (good)	1	1	—	327	1	—
95	Mottled rock	1	1	6	328	2	6
96	Common fire-clay and black bat	—	2	6	329	2	—
97	Grey rock mingled with coal smuts	8	1	—	338	—	—
98	Binds and shale	—	1	—	338	1	—
99	Brown, blue, and grey rock, with a smutty parting	1	2	6	340	—	6
100	Dark binds	2	2	6	343	—	—
101	Dark blue and brown rock	—	—	6	343	—	6
102	Blue and red ground	1	1	6	344	2	—
103	Grey and red rock	1	2	—	346	1	—
104	Green and pink marl	—	2	—	347	—	—
105	Blue and red marl	1	2	—	348	2	—
106	Red rocky ground	7	1	6	356	—	6
107	Grey rock	—	2	—	356	2	6
108	Red and blue ground	1	1	—	358	—	6
109	Fire-clay (good)	1	1	—	359	1	6
110	Fire-clay stained with red and yellow	1	—	—	360	1	6
111	Dark binds	—	1	—	360	2	6
112	Hard brown fire-clay rock	—	1	4	361	—	10
113	Red, blue, and grey rock	—	2	8	362	—	6
114	Grey and dark shaly rock, mingled with fossil plants	3	—	8	365	1	2
115	Dark binds and bat	—	1	2	365	2	4
116	Coal long grained (batty)	—	—	2	365	2	6
117	Strong fire-clay (rocky)	—	2	—	366	1	6
118	Strong rock, mingled with fire-clay	1	—	—	367	1	6
119	Strong gritty rock	4	—	6	371	2	—
120	Dark binds	1	—	4	372	2	4
121	Bat with sheds of coal	—	—	8	373	2	—
122	Dark brown rock	—	2	6	373	2	6
123	Blue and red rock	—	2	6	374	2	—
124	Grey gritty rock (shaly)	4	—	—	378	2	—
125	Dark binds	—	2	6	379	1	6
126	Blue and red rock	1	1	—	380	2	6
127	Mottled ground	—	—	6	381	—	—
128	Dark binds	—	—	6	381	—	6
129	Dark brown rock	—	1	6	381	2	—
130	Blue and red rocky ground	1	2	—	383	1	—
131	Dark grey shaly rock	2	1	6	385	2	6
132	Dark binds	—	1	10	386	1	4
133	Coal (good)	—	—	8	386	2	—
134	Dark fire-clay rock	1	1	4	388	—	4
135	Light-coloured sandstone rock, coarse and gritty	11	1	—	399	1	4
136	Strong blue binds	—	1	—	399	2	4
137	Dark binds, with cakes of ironstone	—	2	—	400	1	4
138	Bat and coal	—	—	6	400	1	10
139	Fire-clay rock	1	—	—	401	1	10
140	Grey and brown rock	1	2	9	403	1	7
141	Sheddy rock bind	—	—	6	403	2	1
142	Grey and brown rock	1	2	6	405	1	7
143	Blue rock bind and dark bind	1	—	6	406	2	1

		Yards.	Feet.	Inches	Yards.	Feet.	Inches
144	Black bat	—	2	3	407	1	4
145	Coal (good)	—	1	1	407	2	5
146	Strong fire-clay rock	—	—	6	407	2	11
147	Hard gritty rock (like limestone grit) ...	—	2	6	408	2	5
148	Dark gritty rock	—	1	2	409	—	7
149	Blue binds	3	—	—	412	—	7
150	Blue and red ground	—	1	—	412	1	7
151	Dark fire-clay clod	1	—	7	413	2	2
152	Hard light blue and grey rock	1	2	8	415	1	10
153	Black bat, dark clod, and rock bind	1	1	6	417	—	4
154	Bat 4 inches, coal 4, bat 4	—	1	—	417	1	4
155	Fire-clay	1	—	3	418	1	7
156	Blue and green rock	1	—	—	419	1	7
157	Red and mottled ground	—	1	—	419	2	7

(End of Sinking.)

BORINGS.

		Yards.	Feet.	Inches	Yards.	Feet.	Inches
1	Grey rock	1	—	6			
2	Dark blue rock bind...	1	—	6			
3	Dark fire-clay rock	1	—	—			
4	Grey rock	1	—	—			
5	Dark fire-clay...	—	1	6			
6	Dark grey rock	—	1	6			
7	Blue rock binds	5	2	—			
8	Dark fire-clay rock (a little bat at top) ...	1	—	—			
9	Red and blue ground	5	1	—			
10	Dark binds (batty)	1	—	—			
11	Bluish grey rock	3	1	6			
12	Dark binds	—	—	6			
13	Dark grey rock	3	2				
14	Basalt or trap-rock	9	1	—	35	—	—
	Total depth proved ..				454	2	7

BRITISH ASSOCIATION MEETING.

The British Association Meeting was held this year at Manchester, and was marked by an unusually large attendance of members and associates.

The President's Address.

The President, Mr. Fairbairn, in his opening address, dwelt but slightly on the progress of Geology—the chief portion of his speech being devoted, as was to be expected, to manufactures and applied mechanics. We give that part of his speech which relates to our science.

"It is little more than half a century since Geology assumed the distinctive character of a science. Taking into consideration the aspects of nature in different epochs of the history of the earth, it has been found that the study of the changes at present going on in the world around us enable us to understand the past revolutions of the globe, and the conditions and circumstances under which strata have been formed and organic remains embedded and preserved. The geologist has increasingly tended to believe that the changes which have taken place on the face of the globe, from the earliest times to the present, are the result of agencies still at work. But whilst it is his high office to record the distribution of life in past ages and the evidence of physical changes in the arrangement of land and water, his results hitherto have indicated no traces of its beginning, nor have they afforded evidence of the time of its future duration. Geology has been indebted for this progress very largely to the investigations of Sedgwick and the writings of Sir Charles Lyell.

"As an example of the application of Geology to the practical uses of life, I may cite the discovery of the gold fields of Australia, which might long have remained hidden, but for the researches of Sir Roderick Murchison in the Ural Mountains on the geological position of the strata from which the Russian gold is obtained. From this investigation he was led by inductive reasoning to believe that gold would be found in similar rocks, specimens of which had been sent him from Australia. The last years of the active life of this distinguished geologist have been devoted to the re-examination of the rocks of his native Highlands of Scotland. Applying to them those principles of classification which he long since established, he has demonstrated that the crystalline limestones and quartz-rocks which are associated with mica-schists, &c., belong by their embedded organic remains to the Lower Silurian Rocks. Descending from this well-marked horizon, he shows the existence beneath all such fossiliferous strata of vast masses of sandstone and conglomerate of Cambrian age; and, lastly, he has proved the existence of a fundamental Gneiss, on which all the other rocks repose, and which, occupying the North-Western Hebrides and the west coasts of Sutherland and Ross, is the oldest rock-formation in the British Isles, it being unknown in England, Wales, or Ireland.

"It is well known that the temperature increases, as we descend through the earth's crust, from a certain point near the surface, at which the temperature is constant. In various mines, borings, and Artesian wells, the temperature has been found to increase about 1° Fahrenheit for every sixty or sixty-five feet of descent. In some carefully conducted experiments during the sinking of the Dukinfield Deep Mine,—one of the deepest pits in this country,—it was found that a mean increase of about 1° in seventy-one feet occurred. If we take the ratio thus indicated, and assume it to extend to much greater depths, we should reach at two and a half miles from the surface strata at the temperature of boiling water; and at depths of about fifty or sixty miles the temperature would be sufficient to melt, under the ordinary pressure of the atmosphere, the hardest rocks. Reasoning from these facts, it would appear that the mass of the globe, at no great depth, must be in a fluid state. But this deduction requires to be modified by other considerations, namely, the influence of pressure on the fusing point, and the relative conductivity of the rocks which form the earth's crust. To solve these questions a series of important experiments were instituted by Mr. Hopkins, in the prosecution of which Dr. Joule and myself took part; and after a long and laborious investigation, it was found that the temperature of fluidity increased about 1° Fahrenheit for every 500lbs. pressure, in the case of spermaceti, bees' wax, and other similar substances. However, on extending these experiments to less compressible substances, such as tin and barytes, a similar increase was not observed. But this series of experiments has been unavoidably interrupted; nor is the series on the conductivity of rocks entirely finished. Until they have been completed by Mr. Hopkins, we can only make a partial use of them in forming an opinion of the thickness of the earth's solid crust. Judging, however, alone from the greater conductivity of the igneous rocks, we may calculate that the thickness cannot possibly be less than nearly three times as great as that calculated in the usual suppositions of the conductive power of the terrestrial mass at enormous depths being no greater than that of the superficial sedimentary beds. Other modes of investigation which Mr. Hopkins has brought to bear on this question appear to lead to the conclusion that the thickness of the earth's crust is much greater even than that above stated. This would require us to assume that a part of the heat in the crust is due to superficial and external, rather than central causes. This does not bear directly against the doctrine of central heat, but shows that only a part of the increase of temperature observed in mines and deep wells is due to the outward flow of that heat."

ADDRESS TO THE GEOLOGICAL SECTION.

By Sir R. I. Murchison, D.C.L, LL.D., F.R.S.

Although I have had the honour of presiding over the geologists of the British Association at several previous meetings since our first gathering at York, now thirty years ago, I have never been called upon to open the business of this section with an address; this custom having been introduced since I last occupied the geological chair at Glasgow, in 1855.

The addresses of my immediate predecessors, and the last anniversary discourse of the President of the Geological Society of London, have embraced so much of the recent progress of our science in many branches, that it would be superfluous on my part to go again over many topics which have been already well treated.

Thus, it is needless that I should occupy your time by alluding to the engrossing subject of the most recent natural operations with which the geologist has to deal, and which connect his labours with those of the ethnologist. On this head I will only say, that having carefully examined the detrital accumulations forming the ancient banks of the river Somme in France, I am as complete a believer in the commixture in that ancient alluvium of the works of man with the reliquiæ of extinct animals as their meritorious discoverer, M. Boucher de Perthes, or as their expounders, Prestwich, Lyell, and others. I may, however, express my gratification in learning that our own country is now affording proofs of similar intermixture both in Bedfordshire, Lincolnshire, and other counties; and possibly at this meeting we may have to record additional evidences on this highly interesting topic.

But I pass at once from any consideration of these recent accumulations, and, indeed, of all tertiary rocks; and as a brief space of time only is at my disposal, I will now only lay before you a concise retrospect of the progress which has latterly been made in the development of one great branch of our science. I confine myself, then, to the consideration of those primeval rocks with which my own researches have for many years been most connected, with a few allusions only to metamorphism, and certain metalliferous productions, &c.

There is, indeed, a peculiar fitness in now dwelling more especially on the ancient rocks, inasmuch as Manchester is surrounded by some of them, whilst, with the exception of certain groups of erratic blocks and drifts, no deposits occur within the reach of short excursions from hence, which are either of secondary or tertiary age.

Let us, then, take a retrospective view of the progress which has been made in the classification and delineation of the older rocks since the Association first assembled at York, in 1831. At that time, as every old geologist knows, no attempt had been made to unravel the order or characters of the formations which rise from beneath the Old Red Sandstone. In that year Sedgwick was only beginning to make his first inroads into those mountains of North Wales, the intricacies of which he finally so well elaborated, whilst I only brought to that, our earliest assembly, the first fruits of observations in Herefordshire, Brecon, Radnor, and Shropshire, which led me to work out an order which has since been generally adopted.

At that time the terms of Cambrian, Silurian, Devonian, and Permian were not dreamt of, but acting on the true Baconian principle, their founders and their coadjutors have, after years of toil and comparison, set up such plain landmarks on geological horizons that they have been recognised over many a distant land. Compare the best map of England of the year 1831, or that of Greenough which had advanced somewhat upon the admirable original classification of our father, William Smith, and see the striking difference between the then existing knowledge and our present acquirements. It is not too much to say that when the British Association first met, all the region on both sides of the Welsh border, and extending to the Irish Channel on the west, was in a state of dire confusion; whilst in Devonshire and Cornwall many of these rocks which from their crystalline nature were classed and mapped as among the most ancient in the kingdom, have since been shown to be of no higher antiquity than the Old Red Sandstone of Herefordshire.

As to Scotland where the ancient rocks abound, though their mineral structure, particularly in those of igneous origin, had necessarily been much developed in the country of Hutton, Playfair, Hall, Jameson, and McCulloch, yet the true age of most of its sedimentary rocks and their relations was unknown. Still less had Ireland, another region mainly palæozoic, received any striking portion of that illustration which has since appeared in the excellent general map of Griffith, and which is now being carried to perfection through the labours of the Geological Survey under my colleague Jukes. If such was our benighted state as regarded the order and characters of the older formations at our first meeting, great was the advance we had made, when at our twelfth meeting we first assembled at Manchester in 1842. Presiding then as I do now over the geological section, I showed in an evening lecture how the palæozoic rocks of Silurian, Devonian, and Carboniferous age, as well as those rocks to which I had assigned the name of Permian, were spread over the vast region of Russia in Europe and the Ural Mountains. What, then, are some of the main additions which have been made to our acquaintance with the older rocks in the British Isles since we last visited Manchester?

Commencing with the oldest strata, I may now assume, from the examination of several associates on whose powers of observation as well as my own I rely, that what I asserted at the Aberdeen meeting, in 1859, as the result of several surveys, and what I first put forth at the Glasgow meeting of 1855, is substantially true. The stratified gneiss of the north-west coast of the Highlands, and of the large island of Lewis and the outer Hebrides, is the fundamental rock of the British Isles, and the precise equivalent of the Laurentian system of Canada, as described by Sir W. Logan. The establishment of this order, which is so clearly exhibited in great natural sections on the west coast of Sunderland and Ross, is of great importance in giving to the science we cultivate a lower datum-line than we previously possessed, as first propounded by myself before the British Association in 1855.*

For hitherto the order of the geological succession, even as seen in the Geological Map of England and Wales or Ireland, as approved by Sir Henry de la Beche and his able coadjutors, Phillips, Ramsay, Jukes, and others, admits no older sediment than the Cambrian of North Wales, whether in its slaty condition in Merioneth and Caernarvon, or in its more altered condition in Anglesea.

The researches in the Highlands have, however, shown that in our own islands, the older palæozoic rocks, properly so called, or those in which the first traces of life have been discovered, do repose, as in the broad regions of the Laurentian Mountains of Canada, upon a grand stratified crystalline foundation, in which both limestones and iron ores occur subordinate to gneiss. In Scotland, therefore, these earliest gneissic accumulations are now to be marked on our maps by the Greek letter *alpha*, as preceding the Roman *a*, which had been previously applied to the lowest known deposits of England, Wales, and Ireland. Though we must not dogmatise and affirm that these fundamental deposits were in their pristine state absolutely unfurnished with any living things (for Logan and Sterry Hunt, in Canada, have suggested that there they indicate traces of the former life), we may conclude, that in the highly metamorphosed condition in which they are now presented to us in North-Western Britain, and associated as they are with much granitic and hornblendic matter, they are for all purposes of the practical geologist "azoic rocks." The Cambrian rocks, or second stage in the ascending order as seen reposing on the fundamental gneiss of the North-West of Scotland, are purple and red sandstones and conglomerates forming lofty mountains. These resemble to a great extent portions of the rocks of the same age which are so well known in the Longmynd range of Shropshire, and at Harlech in North Wales, and Bray Head in Ireland.

At Bray Head they have afforded the Oldhamia, possibly an Alga, whilst at the Longmynd, in Shropshire, they have yielded to the researches of Mr. Salter some worm tracks and the trace of an obscure crustacean.

The Highland rocks of this age, as well as their equivalents, the Huronian

* See Reports of British Association for 1855 (Glasgow Meeting). At that time I was not aware that the same order was developed on a grand scale in Canada, nor do I now know when that order was there first observed by Sir W. Logan. I then (1855) simply put forward the facts as exhibited on the north-west coast of Scotland; viz., the existence of what I termed a lower or "fundamental gneiss," lying far beneath other gneissose and crystalline strata, containing remains which I even then suggested were of Lower Silurian age. Subsequently, in 1859, when accompanied by Professor Ramsay, I adopted at his suggestion, the word "Laurentian," in compliment to my friend, Sir William Logan, who had then worked out the order, and mapped it on a stupendous scale. I stated, however, at the same time, that, if a British synonym was to have been taken, I should have proposed the word "Lewisian," from the large island of the Lewis, almost wholly composed of this gneiss.

rocks of North America, have as yet afforded no trace whatever of former life. And yet, such Cambrian rocks are in parts of the Longmynd, and specially in the lofty mountains of the North Western Highlands, much less metamorphosed than many of the crystalline rocks which lie upon them. Rising in the scale of successive deposits, we find a corresponding rise in the signs of former life on reaching that stage in the earlier slaty and schistose rocks in which animal remains begin clearly to show themselves. Thus, the Primordial Zone of M. Barrande is, according to that eminent man, the oldest fauna of his Silurian Basin in Bohemia.*

In the classification adopted by Sir Henry De la Beche and his associates, the Lingula Flags (the equivalent of the Zone Primordiale of Barrande) are similarly placed at the base of the Silurian System. This Primordial Zone is also classed as the Lowest Silurian by De Verneuil, in Spain; by James Hall, Dale Owen and others, in the United States; and by Sir W. Logan, Sterry Hunt, and Billings, in Canada.†

In the last year, M. Barrande has most ably compared the North American Taconic group of Emmons‡ with his own primordial Silurian fauna of Bohemia, and other parts of Europe; and although that sound palæontologist, Mr. James Hall, has not hitherto quite coincided with M. Barrande in some details,§ it is evident that the primordial fauna occurs in many parts of North America. And as the true order of succession has been ascertained, we now know that the Taconic group is of the same age as the lower Wisconsin beds described by Dale Owen, with their Paradoxides, Dikelocephalus, &c., as well as of the lower portion of the Quebec rocks, with their Conocephalus, Axionellus, &c., described by Logan and Billings. Of the crystalline schists of Massachusetts, containing the noble specimen of Paradoxides described by W. Rogers, and of the Vermont beds, with their Oleni, it follows that the Primordial Silurian Zone of Barrande (the lower Lingula-flags of Britain) is largely represented in North America, however it may occupy an inverted position in some cases, and in others be altered into crystalline rocks.

In determining this question due regard has been had to the great convulsions, inversions, and breaks, to which these ancient rocks of North America have been subjected, as described by Professors Henry and W. Rogers.

* I learn, however, that in Bohemia, Dr. Fritsch has recently discovered strata lying beneath the mass of the Primordial Zone of Barrande, and in rocks hitherto considered azoic the burrows of annelide animals similar to those of our own Longmynd.

† In completing at his own cost a geological survey of Spain, in which he has been occupied for several years, and in the carrying out of which he has determined the width of the sedimentary rocks of the Peninsula (including the Primordial Silurian Zone, discovered by that zealous explorer, M. Casiano de Prado), M. de Verneuil has in the last few months chiefly examined the eastern part of the kingdom where few of the older palæozoic rocks exist. I am, however, informed by him, that Upper Silurian rocks with *Cardiola interrupta*, identical with those of France and Bohemia, occur along the southern flanks of the Pyrenees, and also re-occur in the Sierra Morena, in strata that over-lie the great mass of Lower Silurian rocks as formerly described by M. Casiano de Prado and himself. The southern face of the Pyrenees, he further informs me, is specially marked by the display of mural masses of Carboniferous strata, which, succeeding the Devonian rocks, are not arranged in basin shape, but stand out in vertical or highly inclined positions, and are followed by extensive conglomerates and marls of Triassic age, and these by deposits charged with fossils of the Lias.

‡ The Silurian classification was proposed by me in 1835, and in the following year, 1836, Dr. Emmons suggested that his black shale rocks, which he called Taconic, were older than any I described.

§ Nor are the writings of the Professors W. B. and H. D. Rogers in unison with the opinions of the authors here cited.

In an able review of this subject, Mr. Sterry Hunt thus expresses himself: "We regard the whole Quebec group, with its underlying primordial shales, as the greatly developed representatives of the Potsdam and Calciferous groups (into part of that of Chazy), and the true base of the Silurian system." "The Quebec group, with its underlying shales," this author adds (and he expresses the opinion of Sir W. Logan), "is no other than the Taconic system of Emmons;" which is thus, by these authors, as well as Mr. James Hall, shown to be the natural base of the Silurian rocks in America, as Barrande and De Verneuil have proved it to be on the continent of Europe.

In our own country a valuable enlargement of our acquaintance with the relations of the primordial zone to the overlying members of the Silurian rocks, has been made through the personal examination of Mr. Salter, aided by the independent discoveries of organic remains by MM. Homfray and Ashe, of Tremadoc.

It has thus been ascertained, that the lower member only of the deposit, which has been hitherto merged under the name of Lingula-flags, can be considered the equivalent of the primordial zone of Bohemia. In North Wales that zone has hitherto been mainly characterized by Lingula and the crustaceans Olenus and Paradoxides. Certain additions having been made to these fossils, Mr. Salter finds that of the whole there are five genera peculiar to the lower zone, and seven which pass upwards from it into the next overlying band or the Tremadoc slate. But the overlying Tremadoc slate, hitherto also grouped with the Lingula-flags, is, through its numerous fossils (many of them of recent discovery), demonstrated to constitute a true lower member of the Llandeilo formation. For, among the trilobites, the well-known Llandeilo forms of Asaphus and Ogygia range upwards from the very base of these slates. Again, seven or eight other genera of trilobites, which appear here for the first time, are associated with genera of mollusks, and encrinites, which have lived through the whole Silurian series. Such, for example, are the genera Calymene, Illænus, among crustaceans; the Lingula, Orthis, Bellerophon, and Conularia, among mollusks, together with encrinites, corals, and that telling Silurian zoophyte, the Graptolite. By this proof of the community of fossil types, as well as by a clear lithological passage of the beds, these Tremadoc slates are thus shown to be indissolubly connected with the Llandeilo and other Silurian formations above them; whilst, although they also pass down conformably into the zone primordiale, the latter is characterized by the linguloid shells (Lingulella, Salter) and by the genera Olenus, Paradoxides, and Dikelocephalus, which most characterize it in Britain as in other regions.*

I take this opportunity, however, of reiterating the opinion I have expressed in my work, "Siluria," that to whatever extent the primordial zone of Barrande be distinguished by peculiar fossils in any given tract from the prevalent Lower Silurian types, there exists no valid ground for differing from Barrande, de Verneuil, Logan, James Hall, and others, by separating this rudimentary fauna from that of the great Silurian series of life of which stratigraphically it constitutes the conformable base. And if in Europe but few genera be yet found which are common to this lower zone and the Llandeilo formation (though the Agnostus and Orthis are common to it and all the Silurian strata), we may not unreasonably attribute the circumstance to the fact, that the primordial zone of no one country contains more than a very limited number of distinct forms. May we not, therefore, infer that in the sequel other fossil links, similar to those which are now known to connect the Lower and Upper Silurian series—which I myself at one time supposed to be sharply separated by their organic remains—will be brought to light, and will then zoologically connect the prim-

* In the last edition of Siluria the distinction was drawn between the lower and upper Lingula-flags, but the fauna of the latter is now much enlarged.

ordial zone with the overlying strata into which it graduates? Let us recollect, that a few years only have elapsed since M. de Verneuil was criticised for inserting, in his table of the Palæozoic Fauna of North America, a number of species as being common to the Lower and Upper Silurian. But now the view of the eminent French Academician has been completely sustained by the discovery in the strata of Anticosti, as worked out by Mr. Billings under the direction of Sir W. Logan, of a group of fossils intermediate in character between those of the Hudson River and Clinton formations; or, in other words, between Lower and Upper Silurian rocks. In like manner, a similar interlacing seems already to have been found, in North America, between the Quebec group, with its primordial fossils, and the Trenton deposits, which are, as is well known, of the Llandeilo age.

I have thus spoken out upon the fitness of adhering to the classifications decided upon by Sir Henry de la Beche and his associates long before I had any relation to the Geological Survey, and which places the whole of the Lingula flags of Wales as the natural base of the Silurian rocks. For English geologists should remember that this arrangement is not merely the issue of the view I have long maintained, but is also the matured opinion of those geologists in foreign countries and in our colonies, who have not only zealously elaborated the necessary details, but who have also had the opportunities of making the widest comparisons.

On the continent of Europe, an interesting addition has been made to our acquaintance with the fauna of one of the older beds of the Lower Silurian rocks or the Obolus green sand of St. Petersburg,* by our eminent associate, Ehrenberg. He has described and figured† four genera and ten species of microscopic Pteropods, one of which he names *Panderella Silurica;* the generic name being in honour of the distinguished Russian palæontologist, Pander, who collected them. It is well to remark, that as the very grains of this Lower Silurian green-sand seem to be in great part made up of these minute organisms, so we recognise, in one of the oldest strata in which animal life has been detected, organisms of the same nature, and not less abundant, than those which constitute the deep sea bottoms of the existing Mediterranean and other seas.

Before I quit the consideration of the older palæozoic rocks, I must remind you that it is through the discovery, by Mr. C. Peach, of certain fossils of Lower Silurian age in the limestones of Sutherland, combined with the order of the strata, observed in the year 1827 by Professor Sedgwick and myself, that the true age of the largest and overlying masses of the crystalline rocks of the Highlands has been fixed. The fossils of the Sutherland limestone are not, indeed, strictly those of the Lower Silurian of England and Wales, but are analogous to those of the calciferous sand-rock of North America. The Maclurea is indeed known in the Silurian limestone of the south of Scotland; but the Ophileta and other forms are not found until we reach the horizon of North America. Now, these fossils refer the zone of the Highland limestone and associated quartz-rocks to that portion of the Lower Silurian which forms the natural base of the Trenton series of North America, or the lower part of the Llandeilo formation of Britain. The intermediate formation—the Lingula "flags" or "zone primordiale" of Bohemia—having no representative in the North-Western Highlands, there is necessarily a complete unconformity between the fossil-bearing crystalline limestones and quartz-rocks with the Maclurea, Murchisonia, Ophiléta, Orthis, Orthoceratites, &c., and those Cambrian rocks on which they rest.

A great revolution in the ideas of many an old geologist, including myself,

* See Russia and the Ural Mountains.

† Monats-Bericht d. König. Akad. der Wiss. Berlin, 18 April, 1861.

has thus been effected. Strengthened and confirmed as my view has been by the concordant testimony of Ramsay, Harkness, Geikie, James, and others, I have had no hesitation in considering a very large portion of the crystalline strata of the Highlands to be of the same age as some of the older fossiliferous Silurian rocks, whether in the form of slates in Wales, of greywacke-schist in the southern counties of Scotland, or in the conditions of mud and sand at St. Petersburg. The conclusions as respects the correlation of all the older rocks of Scotland have now indeed been summed up by Mr. Geikie and myself in the Geological Sketch-Map of Scotland which we have just published, and a copy of which is now exhibited.* Not the least interesting part of that production is that which explains the age of all the igneous or trappean rocks of the south of Scotland, as well as all the divisions of the Carboniferous formation, and is exclusively the work of my able colleague.

But if, through the labours of hard-working geologists, we have arrived at a clear idea of the first recognisable traces of life and their sequences, we are yet far from having satisfied our minds as to the *modus operandi* by which whole regions of such deposits have, as in the Highlands, been transmuted into a crystalline slate. Let us therefore hope that, ere this meeting closes, we may receive instructions from some one of the band of foreign or British geologists who have by their experimental researches been endeavouring to explain the processes by which such wonderful changes in the former condition of sedimentary deposits have been brought to light, such as that by which strata once resembling the incoherent Silurian clay which we see in Russia, has been hardened into such rocks as the slaty grauwacke of other regions, and how hard schists of the south of Scotland have been metamorphosed into the crystalline rocks of the Highlands. But why are British geologists to see any difficulty in admitting what I have proposed, that vast breadths of these crystalline stratified rocks of the Highlands are of Lower Silurian age? Many years ago I suggested, after examination, that some of the crystalline rocks near Christiana in Norway were but altered extensions of the Silurian deposits of that region; and, since then, Mr. David Forbes and M. Kjerulf have demonstrated the truth of the suggestion. Again, and on a vastly larger scale, we know that in North America all the noted geologists, however they may differ on certain details, agree in recognising that the vast eastern seaboard range of gneissic and micaceous schists is made up of metamorphosed strata, superior even to the lowest of the Silurian rocks. Logan, Rogers, Hall, and Sterry Hunt are decidedly of this opinion; and the point has been most ably and clearly set before the public by the last-mentioned of these geologists,† who, being himself an accomplished chemist, has given us some good illustrations of the probable *modus operandi* in the bringing about of these changes.

The importance of the inquiries to be made by chemical geologists into this branch of our science was not lost upon the earlier members of the British Association. Even in the year 1833, a committee was appointed to endeavour to illustrate the phenomena of the metamorphism of rocks by experiments carried on in iron-furnaces. After a series of trials on various mineral substances, the Rev. W. Vernon Harcourt, to whom we owed so much at our foundation, has, as the reporter of that committee, been enabled to present to the Association that lucid report on the actual effect of long-continued heat which is published in our last volume. In referring you to that document, I must, as an old practical field-geologist, express the gratification I feel in seeing that my eminent friend has, in the spirit of true inductive philosophy, arrived, after much experiment and thought, at the same conclusion at which, in common with Sedgwick, Buckland, De la Beche, Phillips, and others in my own country,

* This map is already on sale in Manchester.

† "American Journal of Science," May, 1861.

and with L. Von Buch, Elie de Beaumont, and a host of geologists abroad, I had long ago arrived in the field. I, therefore, re-echo their voices in repeating the words of Mr. W. Harcourt, "that we are not entitled to presume that the forces which have operated on the earth's crust have always been the same." Looking to the only rational theory which has ever been propounded to account for the great changes in the crust which have taken place in former periods—the existence of an intense central heat which has been secularly more and more repressed by the accumulation of sediment until the surface of the planet was brought into its present comparatively quiescent condition—our first General Secretary has indicated the train of causes, chemical and physical, which resolve some of the difficulties of the problem. He has brought before us, in a compendious digest, the history of the progress which has been made in this branch of our science, by the writings of La Place, Fourier, Von Buch, Fournet, and others; as well as by the experimental researches of Mitscherlich, Berthier, Senarmont, Daubree, Deville, Delesse, and Durocher. Illustrating his views by reference to chemical changes in the rocks and minerals of our own country, and fortifying his induction by an appeal to his experiments, he arrives at the conclusion, that there existed in former periods a much greater intensity of causation than that which now prevails. His theory is, that whereas now, in the formation of beds, the aqueous action predominates, and the igneous is only represented by a few solfataras, in the most ancient times the action was much more igneous, and that in the intermediate times fire and water divided the empire between them. In a word, he concludes with the expression of the opinion, which my long-continued observation of facts had led me to adopt, "that the nature, forces, and progress of the past condition of the earth cannot be *measured* by its existing condition."

In addition to these observations on metamorphism, let me remind you that, on the recommendation of the British Association, other important researches have been carried on by Mr. William Hopkins, our new General Secretary, and in the furnaces of our President, Mr. Fairbairn, on the conductive powers for heat in various mineral substances. Although these experiments have been retarded by a serious accident which befel Mr. Hopkins, they are still in progress, and I learn from him that, without entering into any general discussion as to the probable thickness of the crust of our planet, we may even now affirm, on experimental evidence, that, assuming the observed terrestrial temperature to be due to central heat, the thickness of this crust must be two or three times as great as that which has been usually considered to be indicated by the observed increase of temperature at accessible depths beneath the earth's surface.

Of the Devonian rocks or Old Red Sandstone, much might be said if I were to advert to the details which have been recently worked out in Scotland, by Page, Anderson, Mitchell, Powrie, and others; and in England, by the researches of the Rev. W. Symonds, and other members of the Woolhope and Malvern Clubs. But confining myself to general observations, it may be stated, that a triple sub-division of that group, which I have shown to hold good over the Continent of Europe as in our own country, seems now to be generally admitted, whilst the history of its southern fauna in Devonshire has recently been graphically and ably elaborated by Mr. Pengelly, in a paper printed in our last volume.

In Herefordshire and Shropshire the passage of the upper members of the Silurian rocks into the inferior strata of the Old Red group, has been well shown by Mr. Lightbody, and the fossils of its lower member have been vigorously collected. Whilst in Scotland Mr. Geikie and others have shown the upward passage of *its superior* strata into the base of the Carboniferous rocks; and Dr. Anderson announces the finding of shells with crustacea in the lower or grey beds, south of the Tay. I may here note, that the point which I have been for some years endeavouring to establish as to the true position of the Caithness flags with their numerous ichthyolites seems to be admitted by my contemporaries. The lamented Hugh Miller considered these ichthyolites as belonging to the lower member of the group, and had good grounds for his views, since at his native place, Cromarty, these fish-beds appear very near the base. But, by following them into Caithness and the Orkneys, I have shown that they occupy a middle position, whilst the true base of the group is the equivalent of the zone with Cephalaspis, Pteraspis, and Pterygotus.

And here it is right to state, that the Upper Silurian rocks which are clearly represented in Edinburghshire, and which in Lanarkshire seem to graduate upwards into the Lower Old Red or Cephalaspis sandstone, are wanting in the Highlands; thus accounting for the great break which there occurs between the crystallized rocks of Lower Silurian age and the bottom beds of the Old Red Sandstone.

Of the Old Red Sandstone of Scotland and Herefordshire I may be permitted further to observe, that its downward passage into the uppermost Silurian rock, and the upward passage of its higher strata into the Carboniferous strata, has been well developed, the one near Ludlow, chiefly through the labours of Mr. Lightbody; the other in Scotland, through the researches of the Government Geologists, Howell and Geikie, as well as by those of Mr. D. Page, and other observers. On this head I may, however, note, what my contemporaries seem now to admit, that the removal of the Caithness flags and their numerous included ichthyolites from the bottom of this group, and their translation to the central part of the system, as first proposed by myself, is correct. In truth, the lower member of this system is now unequivocally proved to be the band with Cephalaspis, Pteraspis, &c., as seen in Scotland, England, and Russia. The great break which has been traced in the south of Scotland by Mr. Geikie between the lower and upper Old Red, is thus in perfect harmony with the zoological fact that the central or Caithness fauna is entirely wanting in that region, as in England—as it is indeed in Ireland, where a similar break occurs.

It gratifies me to add that many new forms of those fossil fishes which so peculiarly characterize the Old Red Sandstone, have been admirably described by Sir Philip de Grey Egerton in the "Memoirs of the Geological Survey," and I must remark that it is most fortunate that the eminent Agassiz is here so well represented by my distinguished friend, who stands unquestionably at the head of the fossil ichthyologists of our country.

Very considerable advances have been made in the development of our acquaintance with that system—the Carboniferous—which in the North of England—Yorkshire—has been so well described by Professor Phillips, and with which all practical geologists in and around Manchester are necessarily most interested. The close researches of Mr. Binney, who has, from time to time, thrown new lights on the origin and relations of coal, and the component parts of its matrix, established proofs so long ago as 1840, that great part of our coal-fields was accumulated under marine conditions; the fossils associated with the coal-beds being, not as had been too generally supposed, of fluviatile or lacustrine character, but the spoils of marine life. Professor Henry Rogers came to the same conclusion with regard to the Appalachian coal-fields in America, in 1842. Mr. Binney believes that the plant Sigillaria grew in salt water, and it is to be remarked that even in the so-called "fresh-water limestones" of Ardwick and Le Botwood, the Spirorbis and other marine shells are frequent, whilst many of the shells termed Cypris may prove to be species of Cythere. Again, in the illustrations of the fossils which occur in the bands of iron ore in the South Welsh coal-field, Mr. Salter, entering particularly into this question, has shown that in the so-called "Unio beds" there constantly occurs a shell related to the Mya of our coasts, which he terms Anthracomya; whilst, as he has stated in the "Memoirs of the Geological Survey," just issued, the very Unios of these beds have a peculiar aspect, differing much from that of true fresh-water forms. They have, he says, a strongly wrinkled epidermis, which is a mark of the Myadæ, or such burrowing bivalve shells, and not of true Unionidæ; they also differ in the interior, as shown by Professor W. King. Seeing that in these cases quietly deposited limestones with marine shells (some of them indeed of estuary character) rest upon beds of coal, and that in many other cases purely marine limestones alternate frequently with layers of vegetable matter and coal, may we not be led to modify the theory, founded on the sound observation of Sir W. Logan, by which the formation of coal has been rather too exclusively referred to terrestrial and freshwater conditions? May we not rather revert to that more expansive doctrine, which I have long supported, that different operations of nature have brought about the consolidation and alteration of vegetable matter into coal. In other words, that in one tract the coal has been formed by the subsidence *in situ* of vast breadths of former jungles and forests; in another, by the transport of vegetable materials into marine estuaries; in a third case, as in Russia and Scotland (where purely marine limestones alternate with coal), by a succession of oscillations between jungles and the sea; and, lastly, by the extensive growth of large plants in shallow seas.

The geological map of Edinburghshire, prepared by MM. Howell and Geikie, and recently published, with its lucid explanations, affords indeed the clearest proofs of the frequent alternations of beds of purely marine limestone charged with Producti and bands of coal, and is in direct analogy with the coal-fields of the Donetz, in Southern Russia.*

In sinking through the extensive coal-tracts around Manchester (at Dukinfield), where one of the shafts already exceeds in depth the deepest of the Durham mines, rigorous attention will, I hope, be paid to the discovery of the fossils which characterize each bed passed through, not merely to bring about a correctly matured view of the whole history of these interesting accumulations, formed when the surface of our planet was first furnished with abundant vegetation, but also for the practical advantage of the proprietor and miner, who, in certain limited areas, may thus learn where iron-ores and beds of coal are most likely to be persistent. In carrying out his survey-work through the north-western coal-tracts of Lancashire, to which the large, or six-inch, Ordnance-map has been applied, one of the Secretaries of this Section, Mr. Hull, has done good service in accurately defining the tracts wherein the elevated coal deposits are covered by drift only, in contradistinction to those which are still surmounted by red rocks of Permian and Triassic age. In seeing that these are eagerly bought by the public, and in recognising the great use which the six-inch survey has proved in the hands of the geological surveyors in Scotland, our friends in and around Manchester may be led to insist on having that large scale of survey extended to their own important district. By referring to the detailed delineations of the outcrops of all the Carboniferous strata in the cities of Edinburgh, Haddington, Fife, and Linlithgow, as noted by Professor Ramsay and MM. Howell and Geikie, the coal-proprietors of England will doubtless recognise the great value of such determinations.

Concerning the Permian Rocks, which were formed towards the close of the long palæozoic era, and constitute a natural sequel to the old Carboniferous deposits, it is to be hoped that we shall here receive apposite illustrations from some of our associates.

When Professor Sedgwick, thirty-four years ago, gave to geologists his excellent Memoir on the Magnesian Limestone of our country, as it ranges from Durham, through Yorkshire, into Nottinghamshire, he not only described the numerous varieties of mineral structure which that rock exhibits, noting at

* See Russia in Europe and the Ural Mountains. Vol. I.

the same time its characteristic fossils, but he also correlated it, and its underlying beds, with the Zechstein, Kupferschiefer, and Rothe-todte-liegende, of Germany. But whilst this is the true order in both countries, there is this considerable difference in England, that along the zone where the Magnesian Limestone exists as a mass, and where Sedgwick described it, the inferior member of the group is a thin band of sandstone, usually of a yellow colour (the Pontefract rock of William Smith), which in its southern extremity, near Nottingham, is almost evanescent. In many parts of Germany, on the contrary, and notably in Thuringia and Silesia, the same lower band, with a few intercalated courses of limestone, swells out into enormous thicknesses and even constitutes lofty ridges.

In Russia the series of this age puts on very different mineral arrangement. There the calcareous bands, containing the very same species of shells as the magnesian limestone of Germany and Britain, are intercalated with pebble-beds, sandstones, marls, and copper-ores, so that, although the same lithological order does not prevail as in the Saxon or typical Permian country of the elder German geologists, the group is, through its fossil types, unquestionably the same. It was from the observation of this fact, and from seeing that these deposits, so mixed up, yet so clearly correlated by their animal and vegetable relics, and all superposed to the Carboniferous system, occupied a region twice as large as the British Isles, in which the varieties of structure are best seen in the government of Perm, that I proposed in 1841, that the *whole group* should have the name of "Permian."

Of late years various British authors, including King, Howse, and others, have ably described the fossil shells of this deposit as it exists on the eastern side of the Penine chain; and recently Mr. Kirkby has produced a carefully written and well-considered memoir, showing the relations of the whole group, by comparing its structure and palæontological contents in Durham with those in South Yorkshire. Whilst, in addition, my associates of the Geological Survey, particularly Mr. Aveline, have been carefully delineating the area of these beds in their northern range from Nottingham through Yorkshire, much yet remains to be done in correlating the Permian rocks lying to the west of the Penine ridge, or where we are now assembled, with their eastern equivalents.

Already, however, great strides have been made towards this desirable end. Thus, Mr. Binney has indicated the succession in the neighbourhood of Manchester, and has shown us that there some of the characteristic fossils of the eastern magnesian limestone exist in red marl and limestones subordinate thereto, and that these are clearly underlaid by other red sandstones, shales, and limestones, which he terms Lower Permian. He has further followed these Lower Permian beds to the west and north-west, and finds them expanding into considerable thicknesses at Astley, Scarisbrick, and other places where they overlie the coal-measures, and he has also traced them into Westmoreland, Cumberland, and Dumfries-shire. In the last case he went far to prove that which I suggested many years ago, that the red sandstones of Dumfries-shire containing the large footprints of chelonians, as described by Sir W. Jardine, are of Lower Permian age.

This view of the relations of the Permian rocks of the north-west has been also taken by Professor Harkness, and this summer he has successfully worked it out, and has definitely applied the Permian classification to large tracts in Cumberland, as explained in a letter to myself. He finds that the breccias and sandstones of Kirby-Stephen and Appleby, which at the latter place have a thickness of three thousand feet, extend northward on the west side of the Eden (the breccia being replaced by false-bedded sandstones with footprints), and attain near Carlisle the enormous thickness of about five thousand feet. These beds he classes unhesitatingly as Lower Permian, because he finds them to be overlaid (near Ormsby) by a group of clays, sandstones, and magnesian limestones, containing peculiar plant remains and shells of the genus Schizodus, representing in his opinion the marl-slate and magnesian limestone of Durham. These again support beds equivalent to the Zechstein, and the last are covered by the Triassic sandstone of the Solway.

A very striking fact, noticed by Professor Harkness, and corroborative of earlier researches made by Mr. Binney, is the existence of foot-prints, in the Lower Permian of Cumberland, similar to those of Corncockle Moor, in Dumfries-shire, where, from my own observations, including those of last year, these Lower Permian sandstones have, I am convinced, a greater thickness even than that which is assigned to them in Cumberland.

Notwithstanding these discoveries, we have still to show the continuous existence of the Lower Red Sandstone of Shropshire, Worcestershire, and Staffordshire, which I have classed as the lower member of the Permian rocks, and to decide whether it be really such lower member *only*, or is to be regarded as the equivalent of the whole Permian group, under differing mineral conditions. With the extension of the Geological Survey this point will, doubtless, be satisfactorily adjusted, and we shall then know to what part of the series we are to attach the plant-bearing red beds of Coventry and Warwick, described as Permian by Ramsay and his associates. We have also to show that, in its northern course, the lower red sandstone of the central counties, with its calcareous conglomerates, graduates into the succession exhibited at Manchester, thence expanding northwards. Already, however, we have learned that in our own little England, which contains excellent normal as well as variable types of all the palæozoic deposits, there exists proofs that the Permian rocks, according to the original definition of the same, present to the observer who examines them to the west as well as to the east of the Penine chain, nearly as great diversities of lithological structure, in this short distance, as those which distinguish the strata of the same age in Eastern Russia in Europe from the original types of the group in Saxony and other parts of Germany.

Geological Survey and Government School of Mines, Mineral Statistics, and Colonial Surveys.—As I preside for the first time over this Section since I was placed at the head of the Geological Survey of Britain, I may be excused for making an allusion to that national establishment, by stating that the public now take a lively interest in it, as proved by a largely increased demand for our maps and their illustrations—a demand which will, I doubt not, be much augmented by the translation at an early day of many of our field-surveyors from the south-eastern and central parts of England, where they are now chiefly employed, to those northern districts where they will be instrumental in developing the superior mineral wealth of the region.

The Government School of Mines, an offshoot of the Geological Survey, is primarily intended to furnish miners, metallurgists, and geological surveyors with the scientific training necessary for the successful pursuit and progressive advancement of the calling which they respectively pursue; but at the same time, the lectures and the laboratories are open to all those who seek instruction in physical science for its own sake, or by reason of its important application to manufactures and the arts. The experience of ten years has led the professors to introduce various modifications into their original programme—with the view of adapting the school as clearly as possible to the wants of those two classes of students; and at present, while a definite curriculum, with special rewards for excellence is provided for those who desire to become mining, metallurgical, and geological associates of the school; every student who attends *a single course of lectures* may by the new rules compete, in the final examination, for the prizes which attach to it only.

Throughout the whole period of the existence of the school, the professors have given annual courses of evening lectures to working men, which are always fully attended, as a part of their regular duty; and during the past year, several of them have delivered voluntarily courses of evening lectures, at a fee so small as to put them within the reach of working men, pupil-teachers, and schoolmasters of primary schools. The professors thus hope to support to the utmost the great impulse towards the diffusion of a knowledge of physical science through all classes of the community, which has been given through the Department of Science and Art by the Minute of the Committee of Privy Council of the 2nd June, 1859.

A body like the British Association for the Advancement of Science should, I conceive, not be unaware of a step of such vast importance, and tending so entirely towards the same goal as that to which its own efforts have been and still are constantly directed.

Now, inasmuch as I can trace no record of the teachings of the Government School of Mines in the volumes of the British Association, and as I am convinced that the establishment only requires to be more widely known, in order to extend sound physical knowledge not merely to miners and geologists, but also to chemists, metallurgists, and naturalists, I have only to remind my audience that this School of Mines which, owing its origin to Sir Henry De La Beche, has furnished our colonies with some of the most accomplished geological and mining surveyors, and many a manufacturer at home with good chemists and metallurgists, has now for its lecturers men of such eminence that the names of Hoffman, Percy, Warington Smyth, Willis, Ramsay, Huxley, and Tyndall are alone an earnest of our future success.

In terminating these few allusions to the Geological Survey, and its applications, I gladly seize the opportunity of recording, that in the days of our founder, Sir Henry De la Beche, our institution was greatly benefited in possessing, for some years, as one of its leading surveyors, such an accomplished naturalist and skilful geologist, as the beloved Assistant General Secretary of the British Association, Professor Phillips, who by his labours threw much new light on the palæontology of Devonshire, who, in the Memoirs of the Survey, has contributed an admirable monograph on the Silurian and other rocks around the Malvern hills, and who, by his lectures and writings, is now constantly advancing science in the oldest of our British universities.

There is yet one subject connected with the Geological Survey to which I must also call your attention, viz., the Mineral Statistics of the United Kingdom, as compiled with great care and ability by Mr. Robert Hunt, the keeper of the Mining Records, and published annually in the memoirs of our establishment.

These returns made a deep impression on the statists of foreign countries who were assembled last year in London at the International Congress. The Government and members of the Legislature are now regularly furnished with reliable information as to our mineral ore produce, which, until very recently, was not obtainable. By the labours of Mr. Robert Hunt, in sedulously collecting data from all quarters, we now become aware of the fact that we are consuming and exporting about eighty millions of tons of coals annually (a prodigious recent increase, and daily augmenting). Of iron ore we raise and smelt upwards of eight millions of tons, producing 3,826,000 tons of pig iron. Of copper ore we raise from our own mines 236,696 tons, which yield 15,968 tons of metallic copper; and from our native metallic minerals we obtain of tin 6,695 tons; of lead, 63,525 tons; and of zinc, 4,357 tons. The total annual value of our minerals and coals is estimated at 26,993,573*l*., and that of the metals (the produce of the above minerals) and coals at 37,121,318*l*.!

When we turn from the consideration of the home survey to that of the geological surveys in the numerous colonies of Great Britain, I may well reflect with pleasure on the fact that nearly all the leaders of the latter have been connected with, or have gone out from, our home Geological Survey and the Government School of Mines.

Such were the relations to us of Sir William Logan in Canada, of Professor Oldham in India, with several of his assistants; of Selwyn in Victoria, of my young friend Gould in Tasmania, as well as of Wall in Trinidad; whilst Barrett, in Jamaica, is a worthy pupil of Professor Sedgwick. Passing over the many interesting results which have arisen out of the examination of these distant lands, we cannot but be struck with the fact, that whilst Hindostan (with the exception of the higher Himalayan mountains) differs so materially in its structure and fossil contents from Europe, Australia, and particularly Victoria, presents, in its palæozoic rocks at least, a close analogy to Britain. Thanks to the ability and zeal of Mr. Selwyn, a large portion of this great auriferous colony has been already surveyed and mapped out in the clearest manner. In doing this he has demonstrated that the productive quartzose veinstones, which are the chief matrix of gold, are merely subordinate to the Lower Silurian slaty rocks, charged with Trilobites and Graptolites, and penetrated by granite, syenite, and volcanic rocks, occupying vast regions. Mr. Selwyn, aided in the palæontology of his large subject by Professor M'Coy, has also shown how these original auriferous rocks have been worn down at successive periods, one of which abrasions is of pliocene age, another of post-pliocene, and a third the result of existing causes. All these distinctions, as well as the demarcation of the carboniferous, oolitic, and other rocks, are clearly set forth. Looking with admiration at the execution of these geological maps, it was with exceeding pain I learnt that some members of the Legislature of Victoria had threatened to curtail their cost, if not to stop their production. As such ill-timed economy would occasion serious regret among all men of science, and would, I know, be also deeply lamented by the enlightened governor, Sir Henry Barkley, it would at the same time be of lasting disservice to the material advancement of knowledge among the mining classes of the State; let us earnestly hope that this young House of Parliament at Melbourne may not be led to enact such a measure.

Whilst upon the great subject of Australian geology, I cannot avoid touching on a *quæstio vexata* which has arisen in respect to the age of the coal-fields of that vast mass of land. Judging by the fossil plants from some of the carboniferous deposits of Victoria, Professor M'Coy has considered these coaly deposits to be of the oolitic or jurassic age, whilst the experienced geologist of New South Wales, the Rev. W. B. Clarke, seeing that where he has examined these deposits, some of their plants are like those of the old coal, and that the beds repose conformably upon and pass down into strata with true Mountain-limestone fossils, holds the opinion that the coal is of palæozoic age. As Mr. Clarke, after citing a case where the coal-seams and plants were reached below Mountain-limestone fossils, expresses a hope that Mr. Gould may detect in Tasmania some data to aid in determining this question, I take this opportunity of stating that I will lay before this meeting a communication I have just received from Mr. Gould, in which he says that in the coal-field of the rivers Mersey and Don, one of the very few which is worked in Tasmania, he has convinced himself that the coal underlies beds containing specimens of true old carboniferous fossils. Remarking that these relations are so far unlike those which he observed on the eastern coast of the island where the coal overlies, yet is conformable to, the carboniferous limestone, he adds that in Tasmania, at least, the coal most worked is unquestionably of palæozoic age.

Now, as Australia is so vast a region, may not much of the coal within it be of the age assigned to it by Mr. Clarke: and yet may not Professor M'Coy be also right in assigning some of the mineral coal to the same oolitic age as the coal of Brora and the eastern moorlands of Yorkshire? In his survey of

Tasmania, Mr. Gould has also made the important discovery of a resinous shale, termed Dysodile, and which, like the Torbane mineral of Scotland, promises to be turned to great account in the production of paraffine.

There are, indeed, other grounds for believing that coal, both of the mesozoic as well of the old carboniferous age, may exist in Australia. Thus putting aside the fossil evidences collected in Victoria by M'Coy and Selwyn, we learn from the researches of Mr. Frank Gregory in Western Australia, that mesozoic fossils (probably cretaceous and oolitic) occur in that region; whilst the Rev. W. B. Clarke informs me in a letter just received, that he is in possession of a group of fossils transmitted from Queensland, 700 or 800 miles north of Sydney, which he is disposed to refer to the age of the Chalk; there being among the fossils Belemnites, Pentacrinites, Pectens, Mytili, Modiola, &c. Again, the same persevering geologist has procured from New Zealand the remains of a fossil Saurian, which, he thinks, is allied to the Plesiosaurus.*

It would therefore appear that in the southern hemisphere there is not merely a close analogy between the rocks of palæozoic age and our own, but further, that, as far as the Mesozoic formations have been developed, they also seem to be the equivalents of our typical secondary deposits.

This existence of groups of animals during the Silurian, Devonian, Carboniferous, and even in Mesozoic periods in Australia and New Zealand, similar to those which characterize these formations in Europe, is strongly in contrast with the state of nature which began to prevail there in the younger Tertiary period. We know from the writings of Owen that at that time the great continent at our Antipodes was already characterized by the presence of those marsupial forms which still distinguish its *fauna* from that of any other part of the world.

In relation to our Australian colonies, I must also announce that I have recently been gratified in receiving from Messrs. Chambers and Finke, of Adelaide, a collection of the specimens collected by McDouall Stuart, in his celebrated traverse (the first one ever made) from South Australia to the watershed of North Australia. Having had occasion to address the Royal Geographical Society on this point, and to award its gold medal to that most adventurous and successful explorer, with observations on the main geographical results of his labours, including the discovery of trees and plants unknown in other parts of that continent, I may here say, in addressing myself to geologists, that a collection of rocks has been submitted to me which may tend to illustrate the structure of the interior of that great continent.

These specimens are soft white chalky rocks, with flints, agates, saline, and ferruginous incrustations, tufas, breccias, and white quartz rocks, and a few specimens of quasi-volcanic rock, but with scarce a fragment that can be referred to the older stages of Lower Silurian age like those of Victoria.† Again, the only fossil shells collected by Mr. Stuart (though the precise latitude and longitude is unknown to me), are Mytiloid and Mya-like forms, seemingly indicating a Tertiary age, and thus we may be disposed provisionally to infer that large tracts of the low interior between East and West Australia have in very recent geological periods been occupied by the sea.

Conclusion.—In concluding this address, I may assure the section that, as one of the original members of the Association, it gives me infinite satisfaction to return to my old friends in this great and thriving centre of our national industry. In common with many of my associates who come from a distance, well do I remember how cordially we were received here in the year 1842;

* In another part of this Number we give the paper of Professor Owen, describing this interesting fossil as *Plesiosaurus Australis*.

† It must, however, be noted that the collection sent to me consists of small specimens of rock forming an imperfect series.

and never can I forget how admirably we were presided over by a nobleman* as distinguished by his ability and learning as he was beloved for his philanthropy and public spirit, and who had upon his right hand the illustrious Dalton. Looking to the character and influence of that philosopher, I may truly say that, as he was one of our founders when we first met together at York, we owe through him a deep debt of gratitude to Manchester; for Dalton was one of the few eminent men who at our birth stood sponsor for our future career, and who supported us at many a subsequent meeting.

In our present visit we are most happy to see placed at our head one of the scientific men of Manchester, who exhibits in his own person the cheering example of the great success which can be attained by the steady and judicious application of science to the improvement of our manufactures. And if England is to hold her own lofty position in great measure through the superior strength of the metal derived from inexhaustible masses of iron-ore which occur in many of her geological formations, we cannot but regard William Fairbairn as the individual who, united at first with the late Eaton Hodgkinson, through a long series of ingenious experiments, as detailed in the volumes of this Association, not only laid the basis for the erection of the Menai Bridge, and such tubular constructions, but who is now directing the manufacture of those iron plates which may best resist the most powerful artillery, whether in casing our ships, or in strengthening our fortresses.

I need not re-affirm that all the men of science who have flocked hither from distant places rejoice with his townsmen in serving under such a man.

Lastly, let me say that we of the Geological Section, who are gathered together from remote parts, have solid grounds for satisfaction in being greeted here by so many good and active brother workmen of the Geological Society of Manchester, who have done such honour to their town, not only by the establishment of a rich and instructive Museum, in which many of the subjects we are met to discuss are thoroughly illustrated, but who have also, by their publications, contributed much to advance our science.

GEOLOGY OF THE NEIGHBOURHOOD OF MANCHESTER.

Mr. E. W. Binney, F.R.S., F.G.S., described the several beds of gravel, sand, and till, forming the superficial covering of the district:—1st. The valley gravel, with its successive terraces; 2nd. The widely-distributed upper sand and gravel; 3rd. The great deposit of boulder-clay or till, which is at some places ninety feet thick; 4th. A lower bed of gravel. The underlying rocks known chiefly by boring operations, were—1st. The trias, or upper red series, about five hundred feet thick; 2nd. The lower new red or Permian series, six hundred feet. These overlie the coal measures, and have been pierced in search for coal at Medlock Vale and elsewhere to the lower Permian beds of Yorkshire. The lower bed of conglomerate is found to thicken out northward in Cumberland and Scotland to some thousand feet in thickness. 3rd. The coal measures of the Manchester coal field, as proved by borings, and by the few local exposures at Ardwick and elsewhere. All of these are exceedingly dislocated, one fault having certainly a down-throw of one thousand and fifty yards.

* Lord Francis Egerton, afterwards the Earl of Ellesmere.

ON THE REMAINS OF A PLESIOSAURIAN REPTILE (PLESIOSAURUS AUSTRALIS) FROM THE OOLITIC FORMATION IN THE MIDDLE ISLAND OF NEW ZEALAND.

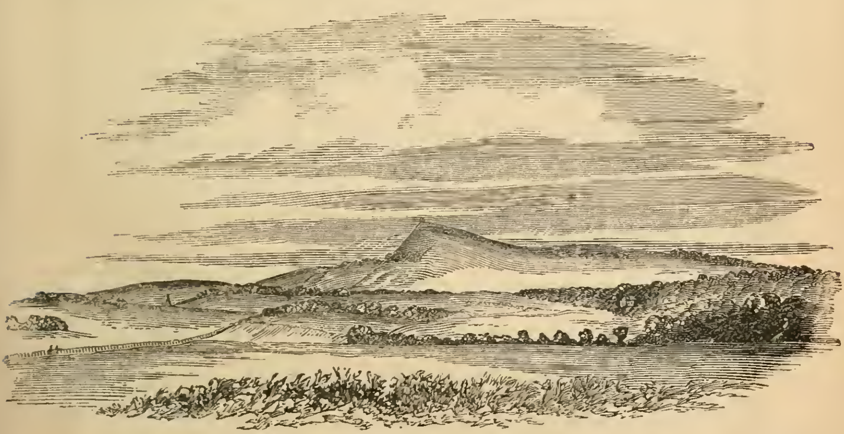
By Professor Owen, F.R.S., &c.

The author, premising a quotation from his "Palæontology," that "the further we penetrate into time for the recovery of extinct animals, the further we must go into space to find their existing analogues;" and that "in passing from the more recent to the older strata, we soon obtain indications of extensive changes in the relative position of land and sea;" cited some striking examples in proof of these propositions from the reptilian class. The Mosasaurus of the cretaceous series occurs in that series in England, Germany, and the United States. The Polyptychodon occurs in the same series at Maidstone and at Moscow. Toothless Lacertian reptiles have left their remains in triassic deposits at Elgin, in Shropshire, and at the Cape of Good Hope. Dicynodont reptiles occur in the same formation at the Cape and in Bengal. The Plesiosaurus, with a more extensive geological range through the jurassic or oolitic series, has left representatives of its genus in those mesozoic strata in England, and at her antipodes. Evidence of this extreme of geographical range had been submitted to Professor Owen by Mr. J. H. Hood, of Sydney, New South Wales, obtained by him from the Middle Island of New Zealand. This evidence consisted of two vertebral bodies, or centrums, ribs, and portions of the two coracoids of the same individual, all in the usual petrified condition of oolitic fossils. Their matrix was a bluish grey clay-stone, effervescing with acid; the largest mass contained impressions of parts of the arch and of the transverse processes of nine dorsal vertebræ, and of ten ribs of the right side. Portions of five of the right diapophyses and of six of the ribs remained in this matrix. The bones had a ferruginous tint, contrasting with the matrix, as is commonly the case with specimens embedded in the Oxfordian or the liassic clays. The impression of the first diapophysis and of its rib show the latter to have been articulated by a simple head to its extremity, as in the Plesiosaurus: but the succeeding rib had been pushed a little behind the end of its diapophysis, and the same kind of dislocation had placed the five following ribs with their articular ends opposite the interspaces of their diapophyses. The ninth rib had nearly resumed its proper position opposite the end of the diapophysis, but at some distance from it; the impression of the tenth rib shows the normal relative position of the pleuro and diapophyses. The ribs are solid, of compact texture, cylindrical, slightly curved; the fragments looking more like coprolites than bone; they are about an inch in diameter, with but small intervals of (say) one-third of an inch, slightly expanding as they recede from the transverse process, and slightly contracting to the lower end. The first terminating in an obtuse end, of half an inch diameter, is seven inches long, the second is eight inches long; the third is eight inches and a half; the fourth rib is nine inches long. The extremities of the others are broken off with the matrix. The separated fossils sent from New Zealand included the mesial co-adjusted ends of a pair of long and broad bones, thickest where they were united, and becoming thinner as they extended outwards, and also towards the fore and hind parts of the bone, both of which ends were broken away. On one side, the surface of the bone is convex lengthwise, and slightly concave transversely. On the opposite side, the contour undulates lengthwise, the surface being concave, then rising to a convexity, where a protuberance has been formed by part of the coadjusted mesial margins of the bone; transversely, this surface is slightly concave. A similar, but less developed, median prominence is seen at the middle of the medially united margins of the coracoids in the Plesiosaurus Hawkinsii, and I regard the above described parts of the New Zealand fossils as being homologous bones. But a more decided evidence of the plesiosaurian nature of this antipodeal fossil is afforded by the vertebral centrums. They have flat articular ends, with two large and two small venous foramina beneath. The neurapophysial surfaces, showing the persistent independence of the neural arch, are separated from the costal surfaces by about half the diameter of the latter. These are of a full oval figure, one inch three lines in vertical, and one inch in fore and aft diameter. On one side of one of the centrums the rib has coalesced with the costal surface. The following are dimensions of this centrum:—Length, one inch nine lines; depth, two inches two lines; breadth of articular end, three inches six lines. The non-articular part of the centrum offers a fine silky character. The shape and mode of articulation of the cervical and dorsal ribs, the shape and proportions of the coracoids, concur with the more decisive evidence of the vertebræ in attesting the plesiosauroid character of these New Zealand fossils, and, pending the discovery of the teeth, the author provisionally referred them to a species for which he proposed the name of Plesiosaurus Australis. The specimens had been presented by Mr. Hood to the British Museum.

ON THE GEOLOGY OF KNOCKSHIGOWNA OR FAIRY HILL, CO. TIPPERARY, IRELAND.

By A. B. Wynne, F.G.S.

In this paper the author described Knockshigowna as a conspicuous hill, rising to a height of 701 feet above the level of the sea, and 400 above the average level of the surrounding limestone plain, and being situated at a distance of six miles S.S.W. of Parsonstown, which is well known on account of



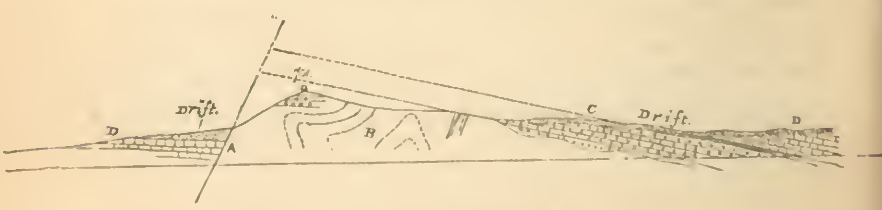
Knockshigowna Hill—from the West.

being the place where Lord Rosse has erected his great telescopes. The hill is a narrow ridge about three miles long, in a S.S.W. direction; its base increasing in width towards the S., at which end its most elevated point occurs.

The eastern and southern slopes of the hill are gentle, but its more abrupt north-western face forms a bold feature in the landscape.

The rocks of which the core of the hill and this steep slope are formed belong to the Silurian series, and consist of grey and bluish hard grits and sandstones, interstratified with coarse conglomerates and fine flaggy and slaty shales.

The eastern and southern slopes of the hill are formed of the Old Red Sandstone, which is represented here by whitish conglomeratic beds, dipping at low angles from the higher Silurian ground towards and underneath the overlying limestones of the surrounding plain. One of the most interesting points in the structure of the hill was stated to be the disappearance of the Old Red Sandstone along its W. or steep flank, in consequence of the occurrence of a fault running along the base of the high ground at that side, nearly parallel to the direction of its crest. By this fault a displacement of the rocks was caused, amounting to more than 800 feet. This fracture does not seem to have been the cause of the occurrence of a hill here, for as the Old Red Sandstone shows a tendency to curve round the N. end of the hill, and actually does so at the S., it seems likely that the hill was originally formed by an anticlinal, the axis of which was arched at this place, and afterwards very obliquely crossed by the fracture, along which the beds to the W. received an opposite or downward curvature. Along the W. side of this fracture the limestone is let down so as to come into juxtaposition with the Silurian rocks, and here, as is frequently



Diagrammatic Cross-section of the Hill of Knockshigowna.

A, Fault; B, Silurian; C, Old red sandstone; D, Carboniferous limestone.

the case along lines of fracture in limestone beds, the rock is converted in places into a (yellowish) crystalline dolomite. In other places where the sequence is undisturbed, the lowest beds of the limestone series immediately overlying the Old Red Sandstone are found to consist of the usual dark earthy limestones, and cleaved, olive, calcareous shales, both being highly fossiliferous.

A peculiar group of red calcareous beds occurs in the Silurian rocks, close to the unconformable boundary of the Old Red, and they may be traced along their strike passing gradually from the ordinary bluish grey into a deep red colour just before they disappear beneath the Old Red Sandstone; a circumstance which is in other places very common along the unconformable boundary between this Old Red Sandstone and the adjacent Silurian, particularly when the latter is composed of shaly beds.

Fossils.—These calcareous red rocks do not appear to contain fossils, but in the vicinity of a remarkable band of conglomerates in the Silurian, near Fairy-mount-gate-lodge, and also in the conglomerate itself, and in the neighbouring shaly flags, fossils were stated to have been found by the author and W. H. Baily, Esq., F.G.S., by the latter of whom the following list was prepared:—

ZOOPHYTA.

Petraia elongata.
Stenopora fibrosa.

ECHINODERMATA.

Criuoid stems and joints.

CRUSTACEA.

Calymene Blumenbachii.
Phacops caudatus.
Encrinurus punctatus.
Proetus latifrons.
Trinucleus concentricus.

MOLLUSCA.

Graptolites priodon.
„ Nilsoni.
Ptilodictya lanceolata.

BRACHIOPODA.

Orthis elegantula.
„ testudiuaria.
„ calligramma.
Leptæna sericea.
Strophomena depressa
„ alternata.
Spirifer trapezoidalis.
Atrypa crassa.
Discina (?).

CONCHIFERA.

Ctenodonta obliqua.
Pterinea tenuistriata.
Ambonychia Triton.
Modiolopsis modiolaris.
„ Nerei.
„ expansa.
Orthonota nasuta.

GASTEROPODA.

Cyclomena. Sp.
Holopella. Sp.
Trochonema. Sp.
Bellerophon bilobatus.
Ecculiomphalus (?).

CEPHALOPODA.

Orthoceras filosum.
„ angulatum.

The discovery of these fossils is interesting, on account of the scarcity of organic remains in the Silurian rocks of this part of Ireland, and their palæontological evidence fixes the age of the beds in which they were found as belonging to the Lower Llandovery period.

Although the rocks containing these fossils are obviously of Silurian age, the author felt called upon to mention incidentally, upon the authority of the discoverer, J. Darby, Esq., that an old Cambrian fossil, Oldhamia radiata, had been found upon the hill, and the specimen itself was laid before the section. A strong probability certainly exists that it might have been found *in situ* here, but unfortunately, as its locality could not now be pointed out, the fact remained to be decided by future discovery.

RECENT ENCROACHMENTS OF THE SEA ON THE SHORES OF TORBAY.

By W. PENGELLY, F.G.S.

If, as some masters of our science tell us, and as I venture to believe, the geological changes which have passed over our world during the unmeasured ages of the past, were due to the direct and indirect operation of existing causes, acting, perhaps, with intensities not greatly dissimilar to those they now display, it can scarcely be out of order to call attention, from time to time, to changes taking place under our immediate observation, even though they may be slight in themselves, and, regarded as isolated facts, of little worth or importance.

Requesting the Section to keep this apologetic preface before them, I will now proceed to narrate a few facts respecting the recent encroachments of the sea on the shores of Torbay.

The rocks composing the horns of the bay, from Hope's Nose to Tor-Abbey Sands on the north, and from Berry Head to Goodrington Sands on the south, are slates and limestones. The former differ much in colour, texture, and fineness of material, and frequently pass into shale. As a whole the limestones overlie the slates; they are sometimes schistose, and are not unfrequently coarse and impure. Both the rocks are subject to divisional planes of various kinds, not fewer than three distinct and definite systems of joints are recognizable, whilst fine and varied examples of cleavage are numerous.

In many cases the limestone strata are strangely contorted, being bent, in more than a few instances, into folds too sharp for the ridge-tiles of the roof of a house, and plunging from top to bottom of cliffs a hundred and fifty feet in height. Though these contortions manifest a certain, perhaps a considerable, degree of plasticity, yet the numerous fractures which a careful scrutiny detects, especially where the folds are sharpest, are so many proofs that the rock was not incapable of breaking at the time of the contortion. Both the slates and limestones are fossiliferous, and belong to the Devonian system.

The central shores of the bay, from Tor Abbey to Goodrington sands inclusive, are made up of red sandstone and conglomerates of probably lower Triassic age. The red rocks do not appear to have suffered so much from mechanical violence as the slates and limestones; nevertheless, joints are by no means rare in them, nor are they exempt from faults. False or diagonal stratification occurs in some of the beds, being chiefly seen in the sandstones, but sometimes met with in the finer conglomerates also.

As might have been expected, the sandstones and conglomerates have yielded more than the other rocks to the destructive agency of the sea; indeed, they have so rapidly retreated before it as considerably to change the outline of the coast, and deprive the proprietors of the soil of much valuable land within the memory of many persons still living. Men who have scarcely completed half a century, speak of having ridden, when far advanced in their teens, from Torquay to Paignton, by a road that has been totally impassable for many years, and of which the merest fragments, "few and far between," at present exist; useful only as proofs of the rapid inroads of the sea. One of these remnants crosses the low headland known as the Carbons, which separates Tor Abbey Sands and Livermead Sands; it is two hundred and eighty feet in length, and at its lowest or northern end, twelve feet above the present strand. The coast-line has retreated to about a hundred and fifty feet within it, or landward; not, however, to find a resting-place there, except through the skilful and laborious services of the engineers of the Torbay and Dartmouth turnpike and railroad.

Fig. 1.—Map of Coast of Torbay.

Fig 1 is a rude map of the coast, on the scale of one inch to one hundred feet, extending from a little north, or the Torquay side, of the Carbons (*f*) to Livermead Head (*g*); the small interjacent bay (*p*) is known as Livermead Sands; *a b* and *c d* are the Torbay and Dartmouth turnpike and railroad respectively; *e* is the fragment of the old road I have mentioned. Fig. 2 is a vertical section of the north end cliff (*a f*) of the Carbons, on the scale of one inch to ten feet, where, as in Fig. 1, *e* shows the situation of the old road, and *a* the Torbay and Dartmouth turnpike-road.

Another fragment extends from the southern end of Livermead Sands to Preston Sands, where it terminates at what is locally known as "Broken Cliff," a philological testimony to the fact that the inhabitants of the district have long recognised the retreat of their coast before the waves. The situation of the Livermead portion of this remnant is shown by the dotted line *c b* in Fig. 1, but the other extremity is not shown in the figure.

Not many years since a breach was made by the sea through the Carbons, and its north-eastern portion thereby converted into a tidal island (*v u*, Fig. 2);

Fig. 2.

prior to this, a fine natural arch existed in a now perished north-easterly prolongation of this detached mass, a drawing of it was made by a daughter of the late Mrs. Griffiths, the eminent algologist, who kindly allowed me to copy it for a diagram (Fig. 3); its situation is indicated by the dotted line *i*, Fig. 2.

Fig. 3.

I am informed by Lord Churston that the Rev. Mr. Edwards, for fifty years vicar of Berry Pomeroy, but who has long been deceased, told him that he remembered two distinct roads, successively made and abandoned, outside, that is, farther seaward than, the road I have just spoken of as existing now in fragments only.

The Torquay and Dartmouth turnpike-road (*a b*, Fig. 1), about twenty-four feet wide, runs in front of Livermead House (*o*), which undoubtedly owes its continued existence to this fact. A sea-wall bounds this road on the outer side all the way from Torquay to the southern extremity of Livermead Sands, excepting only the small portion of it below the Carbons. Not twenty years ago there stood a comfortable cottage in front of Livermead House (*o*, Fig. 1), outside this wall, with an extensive garden still further seaward; outside this again was the old road I have mentioned, and still beyond this a broad margin of cliff, where I have frequently seen children, inmates of the cottage, at play. Cliff, road, garden, and cottage are gone, the sea has swallowed the whole, and well-rounded pebbles now cover a tidal strand, above which they once stood. Nay, more, Neptune too successfully assails the sea-wall every winter; more than once has he been known to have entire possession of the turnpike-road at this point, and to lay claim, with no empty, unmeaning threat, to Livermead House itself; and though, hitherto, the engineer has succeeded in expelling him, it has always been at a considerable expense of skill, labour, and money, and, after all, by what may be termed a sort of compromise. So continually is the wall undergoing reparation, and so great the quantity of limestone quarried somewhere in the interior for this purpose, that I have frequently thought the contending parties must have come to an arrangement somewhat of this nature: "Neptune agrees not to waste the coast on condition that the engineer shall waste the interior to an almost equal amount, and, further, that if the latter allow the smallest crevice to occur in the sea-wall, the former will feel himself at liberty to take opportunity thereof to re-open his claim on the coast."

At the southern extremity of Livermead Sands stands a large house (*r*, Fig. 1), known as Livermead Cottage; it is outside both the turnpike-road and the old road so frequently mentioned; it beetles over the low red cliff faced by a sea-wall, on which it stands in jeopardy every hour. The sea has several times made abortive attempts to insulate it, but it is in all probability a question of time only.

A terrace, or platform, of denudation (*r w*, Fig. 2) extends two hundred and sixty feet from the insular extremity of the Carbons to low-water-mark, the ordinary level of which is indicated by the dotted line *w y*, as is the level of ordinary spring-tide high-water by the line *r d*. This terrace may be taken as a rough minimum measure of the amount of the retrocession of the coast here since the sea and land stood at their present relative level; a minimum certainly, as in this part of the bay the water is very shallow, and a continuation of the platform, constantly covered by the sea, yet within the grinding action of the waves, probably extends at least fully five hundred feet further.

The following seem to be the successive stages through which the work of erosion commonly passes in Torbay. The sea forms a series of small holes at some little distance from one another near the base of the existing cliff; most of these, as might be expected, occur where joints or other fissures afford facilities for the operation; nevertheless, such holes, and not a few, are met with where no points or lines of weakness of this kind exist; some other peculiarity in the rock, for example, the dislodgement of a large pebble from the conglomerate, or some peculiar exposure to the action of the waves, may have determined the situation. When large enough to attract attention, an observer guilty of very absurd comparisons might call them ill-formed, gigantic, unsocial pigeon-holes. A few years at most enlarges them in every direction, and converts them into "ovens," which, in process of time, are in like manner converted into chambers and galleries; the latter especially, where pre-existing divisional planes influence the direction of the work of excavation. Lateral enlargement takes place necessarily at the expense of the partitions between the chambers, until a breach is effected and rapidly enlarged in them, and the whole cliff is found to be honeycombed into a labyrinth of halls and galleries, the roof being supported by massive and fantastic pillars. In this state many of them receive the name of "thunder-holes," from the bellowing noise of the waves rushing into them during storms. More or less rapidly the pillars waste; at length, during a heavy gale, one or more of them snaps across, the superincumbent fabric, if such it may be called, trembles, totters, falls; a new cliff is revealed, protected awhile from the fate of its predecessor by the natural breakwater which the fallen mass forms. This, however, is merely a question of time; the materials are needed where constructive agencies are forming new strata, every tide carries off a portion of the debris, the whole is at length removed, an attack is made on the new and unprotected cliff, and the entire process is repeated with but little variation.

In some cases, however, the mode of attack differs from the above; the waves first proceed to detach a large mass of rock by eroding the cliff at two somewhat distant points, and in no long time convert the interjacent portion into a sort of peninsula; by continually wasting the isthmus is gradually narrowed, until at last the devoted mass is completely insulated, after which its destruction is more rapid. It is astonishing, however, to observe how very long many extremely thin fragments of such islets endure as relics of an ancient coast-line. Those who have visited South Devon will probably call to mind many such fragment between Dawlish and Teignmouth, where this mode of encroachment is more common than in Torbay.

Though, as has been already stated, the other rocks of the district are not wasted so rapidly as those we have just mentioned, nevertheless the destruction of the slates is by no means inconsiderable; their comparatively soft material, and their fissile and jointed character, render them incapable of a very protracted resistance; and when carefully noted, even the hard limestone itself is found to perish more rapidly than might have been expected. The geologist who systematically, and in something like orderly succession, visits and revisits the various parts of the coast, will rarely fail to detect changes in the features of even his limestone haunts; a fresh scar will probably be found graven on the face of the cliff since last he saw it.

Several circumstances concur to bring about this result. Beds composed of small fragments or scales of argillaceous matter, interstratified with the limestone, especially in the Hope's Nose district, waste under the ordinary action of the sea much more rapidly than the calcareous strata, and thus leave considerable vacuities or interstices among the latter. During tempests the sea rushes into these recesses or excavations, and being forced by the enormous pressure of the waves which tower above into the numerous crevices formed by the joints, cleavage, and fissures of other kinds, which, as has been already stated, abound here, rips the rock to an extent scarcely to be credited by those who have never examined such cliffs after a violent storm. Again, between Meadfoot beach and Torquay harbour, the limestone beds are in some places vertical, and reach a considerable height; here, too, similar interspaces are found, caused, however, in this instance by the destruction of the ordinary coarse calcareous shale of the district, which is so frequently found lying between the limestone beds. The sea, driven like a wedge into these openings by the resistless waves which heavy south-easterly gales produce occasionally on this coast, tears off masses of limestone many feet in length and breadth, and of considerable thickness. This was remarkably seen during the violent and too fatal storm of October 26th, 1859, when the limestone cliffs suffered in this way to a very great amount.

The storm I have just mentioned was unusually destructive on the coast of South Devon. The day from its commencement was raw and gusty, the clouds, threatening and ominous, hurried hastily along; a sea, heavier far than the existing force of the wind would account for, fell on the shore, and was explained by seafaring men as the result of "a heavy gale in the offing, which would come home by and by." They prepared accordingly, and "made all snug." The moorings of the shipping in Torquay harbour were carefully examined and rendered secure, and the boats were hauled up high and dry on the quay. As the day advanced so did the storm; early in the afternoon it was blowing a heavy gale from the south; about four o'clock it veered round to the south-east—almost the only wind that can do the bay much mischief—and blew a hurricane for about two hours at the critical juncture of an unusually high spring-tide high-water. The waves were awful; everything seemed to be helplessly abandoned to their fury, and savagely they used their opportunity.

The turnpike-road between Torquay and the railway station was not only impassable during the tempest, but all but totally destroyed. As an early intimation that an unusual attack on the road was in prospect, the waves leaped across it, tore up a somewhat temporary wooden toll-house, rushed with it over a wall, across a field, and finally lodged it near the barn at Tor-Abbey. In some places a breach was first made in the sea-wall, and huge masses of limestone thus dislodged were used with terrible effect as missiles to aid in the work of demolition, and were ultimately thrown, in wild confusion, on such parts of the road as remained otherwise uninjured. In others portions of every wave rushed through crevices between uncemented cyclopean blocks of limestone forming parts of the masonry, and spouted in fearful jets up through the road where a moment before it seemed firm, compact, unimpaired, and unyielding, whilst in other parts, where there were no such indications of subterranean mischief, a heavier wave than usual would spring over the parapet, violently crush what may be called the floor of the road, and reveal huge cavities beneath; the road having been undermined and literally sucked through interstices in the wall built for its protection. In one place a portion of the parapet nine feet long by three in breadth and depth, and, therefore, containing eighty-one cubic feet, was removed *en masse* twenty-five feet horizontally, landward, across the road, where it was found, after the storm in an inverted position, the cement still firmly holding the parts together. By careful experiment I found that a portion of this mass, weighing ninety-nine and a half ounces avoirdupois, displaced seventy-one cubic inches of water, consequently the entire block of masonry thus transported must have weighed about five and a-half tons. Before its dislodgement, the base of this mass was six feet above the level of high-water equinoctial spring-tides.

At Livermead the greater part of the wall and road were completely swept away, and a shingle-beach put in possession of the site.

The whole of the damage above described is now nearly repaired, that is to say, the labour of two years at a cost of five or six thousand pounds is required to represent the mischief effected by the sea in two hours.

The sea-wall has been rebuilt very much on the same plan as before. In reply to a suggestion that it should be constructed on sounder principles, so as to provide against a recurrence of so much damage and inconvenience, it was stated that the cost would at least be double, and that, judging from the past, it may be hoped that the wall put up will last twenty years, whilst at five per cent. compound interest money doubles itself in fourteen years.

The same storm so completely destroyed a sea-wall and road extending nearly the whole length of Meadfoot beach, on the east of Torquay, constructed at a great cost, about seven years before, that no attempt has been made to restore it, but a road in lieu thereof opened in a less exposed situation.

At the northern corner of Goodrington Sands there is a cottage standing in a quadrangular garden, the eastern or seaward wall of which is twenty-five feet from the house, three feet high on the inside and seven feet on the outside, so that the terrace on which the cottage and garden are is about four feet above the highest level of the beach. In still weather there is ample room between this wall and the margin of spring-tide high-water to allow carts to pass. During the storm, however, the waves bounded over the wall, ran across the garden, smashed the drawing-room window, completely re-arranged the furniture in the room, transported a very heavy piano from one side of it to the other, and then departed, taking with them most of the articles of furniture of a light character.

Facts of this kind forcibly show how great the encroachments of the sea must have been within a comparatively short time. Men do not usually build houses in situations thus exposed; the encroachment of the sea has rendered their sites perilous. And though it is happily true that such storms are not of very frequent occurrence, nevertheless many of us can remember so many of them that we cannot but look for them in the future; that is to say, we recognise them as part of the system of nature, not necessarily destructive on every coast, but by no means of very limited range, and certainly an important part of the machinery now modifying the crust of the earth.

ON THE EXCESS OF WATER IN THE REGION OF THE EARTH ABOUT NEW ZEALAND; ITS CAUSES AND ITS EFFECTS.

By James Yates, M.A., F.R.S. and G.S.
(Member of the Geological Society of Manchester.)

The author, adopting from Professor Guyot ("Earth and Man," translated by Mr. Clarke, of Battersea) the terms "land-hemisphere" and "water-hemisphere" to distinguish the portion of the earth which includes "the four quarters of the globe" from that portion which consists mainly of water, observed that instead of the old distinction between the northern and southern hemispheres, the cultivators of physical geography have now made a much more accurate statement of the facts by assuming a point in the South Pacific Ocean, not far from New Zealand, as a centre, around which the entire waters of the globe appear to be collected. He referred to the Physical Atlas of Berghaus, published in Berlin, as containing the most accurate representation of this view of the subject, and thought that this has the highest authority, because, in constructing it Berghaus was assisted and directed by two of the most eminent of his fellow-citizens in this department of science, Alexander von Humboldt and Professor Karl Ritter. The author mentioned that English geographers have prepared maps which give the same general view, but take London and the antipodes of London as the two centres, in order to accommodate English conceptions. He exhibited the beautiful Training-school Atlas, just published by the Messrs. Philip, of London and Liverpool, as containing the largest and best examples of representation. It appeared necessary, however, instead of regarding the waters as ramified in every possible way by their distribution into oceans, seas, bays, and straits, to collect them in imagination into one; hence, preserving Berghaus' centre, which is situated in the meridian of a hundred and seventy degrees east longitude from Paris, and in about four hundred and thirty south latitude, the author presented on a diagram "an Ideal Section of the Earth in the Meridian of New Zealand." Two points in the circumference of this section, named A and B, represented the division between the collected land and the collected water, and the author produced statements from Professor Rigaud of Oxford, Professor Link of Berlin, Alexander von Humboldt, and Sir John Herschell, all tending to show that the entire amount of land on the surface of the globe being taken as a hundred, the entire amount of water will be two hundred and eighty-nine, or nearly so. He took the exact number, two hundred and eighty-nine, because it is the square of seventeen, one hundred being the square of ten. He thought that by the adoption of these numbers, the points A, B in the diagram might be exactly fixed, and that the chord joining them would divide the land (in the section) from the water with a great approach to accuracy, and, moreover, that this chord might be easily drawn on his diagram, because twenty-seven, *i.e.*, ten and seventeen, being also equal to three times nine; it is extremely easy to divide the circle in the manner required by using its radius in the ordinary way. A diameter bisecting this chord at right angles, and drawn to the supposed centre of the water-hemisphere, forty-three degrees south latitude, necessarily passes both through the geometrical centre of the earth, and through its centre of gravity. As the basis of this construction of the diagram, it was assumed that the two constituent areas of the earth's surface, consisting of land and water, are as the squares of the arcs by which they are bounded.

The author briefly controverted the statements of Peterman and Sir John Herschell, who ascribe the appearance in question to "tumefaction," or the "superior intensity of the causes of elevation in northern latitudes, and in former geological epochs," observing that if earthquakes and volcanos are evidences of such superior intensity, the elevated land ought to be on the opposite side of the globe, since the volcanos are three times more numerous in the water than in the land-hemispheres. He wished to ground his speculations on existing facts, and regarded them as proofs that as one half of the moon is probably heavier than the other half, so the earth is heavier on the water- than on the land-side. He supposed the greater weight on the water-side to be produced partly by an excess of mineral veins, beds of ironstones, and basaltic rocks, with others of high specific gravity on that side, and partly by an excess of hollows and cavities filled with water on the other side. Hence would result the conclusion, admitted by Sir J. Herschell, that the earth's centre of gravity is different from its centre of form, or geometrical centre. The author was proceeding to show how the amount of this eccentricity might be computed with some approach to accuracy, but the President expressed the opinion, in which the author cheerfully concurred, that a subject, the treatment of which required so much of mathematical demonstration, was better adapted to be pursued in another section.

Besides the diagram already referred to, the author showed another containing a list of ten of the highest mountains dispersed through the land-hemisphere, and of ten dispersed in like manner through the water-hemisphere, for the purpose of illustrating the fact that the mountains of the land-hemisphere are uniformly of a much greater elevation above the sea-level than those of the water-hemisphere. The heights of all these mountains were given in metres.

The sums of the heights of the one group and of the other, by striking off a cypher at the end of each, gave the average heights of the mountains in each group. Regarding them as gauges for measuring the depth of the ocean, and presuming that the mountains, which rise above submerged continents in the water-hemisphere, and present their summits in the form of innumerable islands, are, generally speaking, and relatively to the solid sphere of the earth, equal in elevation to the mountains of the land-hemisphere, the author drew the conclusion that the general depth of the ocean (its central portion) may be taken as approaching to two kilometres, and that the depths much exceeding this must be attributed to local disturbance.

ON ISOMETRIC LINES, AND THE RELATIVE DISTRIBUTION OF THE CALCAREOUS AND SEDIMENTARY STRATA OF THE CARBONIFEROUS ROCKS OF BRITAIN.

By Edward Hull.

As it is intended that this paper shall be laid before the Geological Society of London, only a short abstract can be presented here.

The author endeavoured to show that during the Carboniferous period a barrier of land stretched across central England from Wales to the German Ocean. To the north of this barrier, or isthmus, the coal-fields of Salop, Staffordshire, Warwickshire, and Leicestershire, and all the Carboniferous strata of the north of England were accumulated; while on the south of the isthmus were found the coal-fields of South Wales, Forest of Dean, Somerset, and possibly of the Thames Valley.

. It was then argued that a broad distinction is to be drawn between limestones and all sedimentary strata, the former having been the production of living animals, which generally required clear water for their proper development, the latter being due to deposition from more or less muddy or sandy seas. The agencies in each case have been in some degree antagonistic; and where the ocean has been, or is at present, highly charged with sediment, limestones cannot be found to any great extent. This view—which is exemplified by many of our seas—is borne out by the relative distribution of the calcareous and non-calcareous members of the Carboniferous group. The sedimentary strata (sandstones, shales, and clays) were shown to attain their greatest vertical development in Scotland, the Borders, and Lancashire, and from thence to thin away towards the south, till they finally terminate against the barrier. On the other hand, it was shown that the Carboniferous limestone reached its highest development in Derbyshire, and from thence thins away westward and northward into Scotland, where it is almost entirely replaced by sedimentary strata. Thus where the one group of beds is most fully developed, there the other is least. These phenomena had long since been pointed out by Professor Phillips in Yorkshire, but are applicable to the whole of Britain north of the barrier. On the south, it was shown that the sedimentary strata are in greatest force towards the W.S.W.—thinning away northwards and eastwards—while the limestones become most fully developed towards the east.

Reverting to America, the author reminded the Section how similar phenomena had been shown by Professor Rogers, Sir C. Lyell, and others, to hold good in that country, but under somewhat different circumstances. They all, however, indicated the existence of land in the North Atlantic during the Carboniferous period. The thickening of the sedimentary strata in Britain towards the north-west, Mr. Hull attributed to the prevalence of a great current (an old Gulf-stream), carrying the sediment from the shores of this North Atlantic continent, and spreading it over submerged Britain. The sea thus became purer as the distance from the source of the sediment increased—that is, towards central England—and here, on the other hand, the crinoids and corals were most active in forming limestones.

The variations in the thicknesses of the two kinds of strata were represented by curved lines drawn on maps (termed isometric lines), each of which marked a given thickness from 1000 to 10,000 feet. One set of lines showed the development of the sedimentary beds, the other of the calcareous. There were thus two systems of concentric lines intersecting each other from opposite directions, and gradually dying out like waves emanating from a focus of disturbance.

The author had previously shown that the sedimentary strata of the Lower Mesozoic series reach their greatest development towards the north-west of England, and thin away in the direction of the estuary of the Thames, where they are altogether absent, as proved by the Harwich boring. All this showed that the sediment had been drifted from the north-west—the waste of probably the same continent which had furnished the materials for the Carboniferous Rocks. Here, then, we have evidence of a great North Atlantic continent existing throughout the Upper Palæozoic and Lower Mesozoic periods, whose shores were swept by an oceanic current, which carried off the sand and mud of its shores and rivers to form the materials of future geological formations.

ON A SECOND NEW BONE CAVERN RECENTLY DISCOVERED AT BRIXHAM, DEVONSHIRE.

By W. Pengelly, F.G.S.

About the end of last March (1861) information was brought me of the discovery, at Brixham, of a second new cavern, rich in fossil bones. I lost no time in visiting it, and, at this and several subsequent visits, made myself acquainted with the facts which form the subject of this paper, and which, though they may add but little, probably nothing, to our knowledge, it is hoped may not prove uninteresting to the section, more especially as the district has become famous in its connexion with "Bone Caverns."

The greater part of the fishing-town of Lower Brixham, or Brixham Quay, as it is commonly called in the neighbourhood, but which I shall call Brixham, without any qualification, occupies a valley, running nearly east and west, which is separated from Torbay on the north by a limestone hill, reaching the height of 150 feet above the sea, and known as Furzeham Common. The southern boundary of the valley consists of four hills, forming a chain parallel to Furzeham, but extending fully a mile further eastward, where it terminates in the promontory of Berry Head, the southern horn of Torbay. The first, that is, the most westerly of these hills is known as Parkham Common, the second is Windmill Hill—in the north-western angle of which the now celebrated cavern was discovered in 1858; the third is Heath Hill, or Common, which contains, near its north-eastern corner, the well-known "Ash-Hole," partially explored, many years ago, by the Rev. Mr. McEnery and the Rev. Mr. Lyte; the fourth, that is, the most easterly hill of the chain, is that of which Berry Head is the almost precipitous termination.

Considerable limestone quarries have been worked in the Torbay slope of Furzeham Hill; one of these, known as Bench, but a short distance from Brixham harbour—indeed, it is within what is legally considered to be the limits of the harbour—had been all but abandoned for upwards of twenty years; recently, however, quarrying operations, on a limited scale, were resumed, and led to the discovery just named.

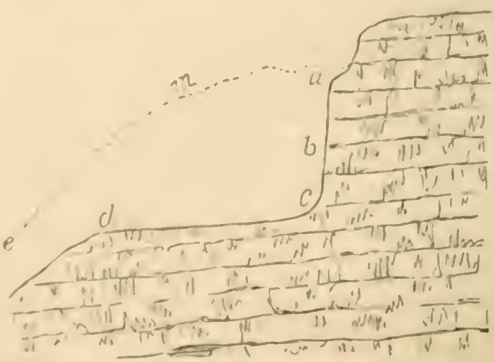


Fig. 1.

Though the axis of the hill has an almost east and west direction, its coast-line at Bench runs nearly west and south, and the quarry has been worked at right angles to this. Fig. 1 represents a vertical east and west section of the hill, on the scale of $\frac{1}{10}$ of an inch to the foot, drawn from careful measurements.* The bottom of the figure is supposed to be the level of low water spring-tides. The dotted line, *a, m, o, e, g*, indicates the original profile of the coast on the assumption that at this place it resembles the general contour where it still remains untouched by the hand of man. The outline, *a, b, c, d, e, g*, of the coloured portion of the figure shows the artificial cliff produced by the quarrying operations; consequently the space between this and the dotted line shows the amount of rock which has been removed.

An attempt is made in Fig. 2 to show, at one view, a portion of the back and left-hand, that is the west and south, walls of the quarry, on the scale of $\frac{1}{4}$ of an inch to the foot. Near the top of the west or back wall, and almost

Fig. 2.

at the angle formed by the intersection of the south wall with it, is a dike (*a, b*, in Fig. 2) of breccia made up of bones, reddish clayey earth, and angular pieces of limestone; the last evidently derived from the immediately adjacent rock, and varying in size from the merest fragments to slabs fully a foot square and six inches thick. The earth is in all respects similar to that in which the bones are imbedded in the caverns of the Torbay district generally. The dike is vertical, has a north and south direction, is 27 feet high, 12 feet long, and 2 feet thick at its southern end; it thins out at its northern extremity, so that it is wedge-shaped; its base is about 96 feet above the level of low-water spring-tides, so that its summit, which reaches the unquarried surface of the cliff, is about 123 feet above the same level. It may be stated here that the base of this mass of breccia is on the same level as the "bone bed" in the famous Windmill Hill Cavern already alluded to. The situation of the dike is seen at *a, b*, in Fig. 1, which shows a vertical section at right angles to its length so as to show its thickness, *i.e.*, $\frac{1}{240}$ its real thickness.

There can be no doubt that this mass of bone-breccia filled a north and south fissure, or, possibly, a portion of such fissure; whether it formerly extended further northwards cannot now be determined, the limestone having been too far removed there to leave any means for forming an opinion on this point.

* The measurements refer to the diagrams exhibited at the meeting, which were in size, 2 feet, by 1 foot, 7 in. The woodcuts are, of course, much reduced, and their scale is about $\frac{1}{10}$ of the linear measurement of the diagrams.

Originally, then, the dike must have been situated somewhat as is shown at *a b*, in Fig. 3, which is drawn on the scale of half an inch to the foot. The limestone in front, that is on the left in the figure, is supposed to be restored.

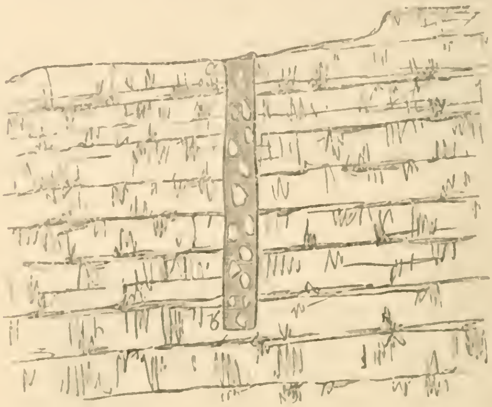


Fig. 3.

It happens that a considerable part of the outer, that is the eastern, or shall I call it seaward, wall of the fissure was removed, in the ordinary course of quarrying, upwards of twenty-two years ago, so that the northern end of the face of the dike, or more correctly, every part of it, excepting about three feet in width, of its southern end, was revealed at that time, and in its face, thus exposed, lay several fine bones quite open to the day; one in particular, the left ramus of a lower jaw bristling with teeth, a most tempting-looking relic of, probably, the cave-hyæna, not only failed to attract the attention of the workmen at the time, but all its efforts to bring itself into notice were utterly fruitless during twenty-two years. We will hope, for the credit of all whom it may concern, that it was somewhat less conspicuous before it was washed and bleached by the rains and sunshine of nearly a quarter of a century.

Fig. 4.

It is attempted in Fig. 4 to represent the condition of the dike during the period I have mentioned; the figure is supposed not to show its entire height, but the lower portion only, and the mass of limestone, *u w*, must be understood to conceal about three feet of its southern end.

Soon after the workmen recommenced their labours in the quarry last March, the removal of this remnant of the outer wall caused the fall of an uncemented portion of the dike which it had previously supported; loose stones, earth, and bones came down together, and thus compelled attention. An invitation of this kind could not be resisted; the principal workman collected the bones, and in a short time found he had got together a considerable number, probably several hundred, consisting of teeth, jaws, skulls, vertebræ, portions of horns, with a large quantity of unidentifiable bone-debris.

Should it be asked—Is it certainly known that that which has been called a dike was really one? Instead of a thin slice of bone-breccia filling a narrow slit in a limestone hill, may it not have been a remnant of a much more considerable accumulation, which once occupied a large chamber or cavern, all but entirely destroyed by the workmen during their former workings? It may be answered, that workmen, however incurious and uninformed, could scarcely, by any possibility, fail to discover that they had broken into a bone cavern, especially in the very neighbourhood of the famous "Ash Hole," and within a very few miles of the more celebrated "Kent's Hole," both of which had about that time attracted much attention, and had taught quarrymen that cave-bones were convertible into gold; whereas a mere fissure would be very likely to pass unnoticed, or, at most, with but little remark, since they are extremely numerous, and constantly met with by the workmen. Moreover, as has been already said, a portion—about one-fourth—of the outer wall of the fissure was still standing *in situ* when the workmen resumed their labours last March. Further, the exposed surface of the breccia itself gave conclusive evidence on the question; it is so perfectly wall-like that it is difficult, if not impossible, to believe that it could have been formed otherwise than has been supposed. The handwriting of the departed limestone wall was still legible on the broad sheet of breccia that had been so long exposed.

It may be remarked here that almost all the very numerous joints and fractures in the Brixham limestone have a north and south (magnetic), or nearly east and west direction or strike. A considerable number of these, of both sets, are filled with red sandstone, varying from mere thread-like veins, to dikes three feet wide, occasionally containing angular pieces of limestone, and sometimes traversed by veins of carbonate of lime. It is, perhaps, somewhat darker and harder; but in all other respects it so closely resembles the red sandstone of the central shores of Torbay, as to suggest the idea that the fissures existed and were filled in the early age represented by these sandstones, probably the triassic; whilst others, having the same directions, remained open, or were re-opened to be filled, amongst other things, by the remains of animals which were contemporary with man himself. Several questions present themselves here; but, being foreign to the purpose of this paper, must be left without further notice at present.

Very near the left or southern foot of the dike is the mouth of a small tunnel (*r*, Fig. 2), having a stalagmitic floor; its extent is not known. In the left or southern wall of the quarry two somewhat large chambers occur (*u* and *s* in Fig. 2); they are partly filled with the same reddish clayey earth and limestone debris, the ordinary cave deposit of the district. They are known to be connected; but whether they have any communication with the tunnel just mentioned is uncertain; no attempt whatever has been made at exploration; but it is extremely probable that they are all parts of one considerable cavern.

All the materials composing the dike undoubtedly fell, or were washed in from above; furnishing a clear and good example of what probably occurred at Orestone, near Plymouth, where the observed phenomena appear to compel the belief that the fossil bones must have found ingress, in this way, to the chambers in the heart of the limestone, though traces of an open fissure have not always been so distinct there as could have been wished.

Whether at Bench a passage from the tunnel was the channel through which the chambers received their contents, is not at present known; excavations would probably soon determine this.

At my first visit an effort was made to purchase the right of taking down the remainder of the dike and thoroughly exploring the chambers; for some time there was a prospect of this being secured, but the proprietor, Mr. Wolston, has at length decided on sooner or later investigating it himself; and though this may be regretted, it is but just to add that he has at all times allowed me the freest access to his premises, has promised to keep me fully acquainted with the progress of the investigation, to allow me to note every fact that may be disclosed, to be used, at my discretion, for the purpose of science, and has favoured me with the loan of the specimens exhibited.

No opinion can be given as to whether or not flint implements or other indications of human existence may be found in the cavern; nothing whatever is known about its extent or contents at present, and the only apology I can offer for having brought so immature a subject before the section is, my desire to keep it fully acquainted with every fact that discloses itself in the district in connexion with these interesting mausolea.

Every one acquainted with the Torbay limestone will be prepared to hear of the discovery in it of new caverns at any time and in any number. Three or four, at least, can at this moment be pointed out within a short distance north and south of Bench; one at Freshwater quarry is known to be upwards of forty feet in length; neither it or either of the others has yet been explored; they may be rich in organic remains, replete with evidence on the great question of the antiquity of the human race, or they may be totally void of scientific fact.

The discoveries made at Brixham in 1858 gave a stimulus, both to those who hope to gain knowledge and those who hope to gain money, which will not soon be lost. Quarrymen will not in future be so blind to their own interests as to lay open a dike of osseous breccia without discovering that they have done so, nor will proprietors hereafter be likely to use the language with which one replied to a question I put to him some time ago respecting a cavern which had been traced into his property. At first he knew nothing about it,—"There was no cavern in his ground, certainly." At length, brightening up, he exclaimed,—"Now you mention it, I do remember that I once saw a very large hole in the rock, and I filled it up by throwing twenty cartloads of rubbish into it." The fear may now be in the opposite direction. An unreasoning love of gain may induce an ignorant activity to exhume the bones, to the great loss of science.

NOTICE OF THE ELSWORTH AND OTHER NEW ROCKS IN THE OXFORD CLAY, AND OF THE BLUNTISHAM CLAY ABOVE THEM.

By Harry Seeley.

The Elsworth rock is a dark blue orgillaceous limestone full of deeply ferruginous oolitic grains, and to some extent interlaced by thin veins of iron-pyrites. It consists of three subdivisions, a lower rock seven feet thick, a middle clay of about five feet, and an upper rock of nearly two feet, making a total thickness of fourteen feet. The fossils are such that the upper rock is readily distinguished from that beneath, while, by the same means, the middle clay is with equal ease separated from those clays above and below it. The rock dips down to the south, and at a distance of three miles the middle clay is replaced by sand.

Five miles north of Elsworth the St. Ives rock comes to the surface, and dips to the east. It is a hundred and thirty feet beneath the Elsworth rock, and very similar to it in mineral character. Its thickness is three feet, often divided into two beds by a parting clay. It is brought up by an anticlinal, so that on high ground four miles north the Elsworth rock is again met with.

Six miles west of Elsworth is found the St. Neotts rock, which is deep down beneath the St. Ives rock, though not so low as the zone of the Kelloway rock.

But for the breaks by these rocks, the lowest beds of Oxford clay would graduate up, without any perceptible change in life, into the highest beds of the Kimmeridge clay, the coral-rag being absent as such, but represented by a clay. This clay contains a mixture of the fossils of the clays above and below, and is met with above the Elsworth rock at Elsworth and Bluntisham. From the exhibition at the latter place it is named the "Blunt'sham clay." The clay beneath the Elsworth rock is the Oxford clay, so that the Elsworth rock is intermediate in position between that subdivision of the great clay formation and the coral-rag. The fossils unmistakeably show it to belong to the clay rather than the limestone formation, and hence it will be regarded as the highest zone of the Oxford clay, while the St. Ives, St. Neotts, and Kelloway rocks will serve to mark the several zones into which the formation is naturally divided by its fossils.

Thin rocks have also been met with in the Bluntisham clay in positions which render it probable that they indicate divisions corresponding to coral-rag and calcareous grit.

ON THE PLEISTOCINE DEPOSITS OF NORTH AMERICA.

By Dr. Hector.

The author stated, that his recent researches in that country afforded strong grounds for supporting the view, that the diffusion of the erratic drift must have resulted from the submergence of the north-east part of the Continent beneath an arctic sea to a depth of nearly 3000 feet, and that the surface of the country has received much of its present form by denudation during its re-emergence, at first along sea-coast lines, and latterly along the shore lines of inland lakes, which still exist, but of much smaller size than formerly. By the steppes which have thus been found these deposits may be divided as follows:—

Bordering the lower part of the valley of the St. Lawrence and extending southwards through the valley of Lake Champlain, a marine deposit of boulder clay has been described with mollusca, more arctic in their character than those existing in the neighbouring seas at the present day. This deposit has not been observed at a greater altitude than 600 feet,* and in its nature it would seem to resemble those deposits that must be forming at present in Hudson Bay and in the Arctic inlets and sounds, where the shore ice, kept in motion by the winds and tides, acts like a pug-mill in reducing the previously deposited drift to the condition of tough clay.

On the shores of Puget Sound and the Gulf of Georgia, in latitude 49° N., on the west side of the Continent, there are drift clays with boulders and scratched rock surfaces, which, like those clays in the St. Lawrence Basin, do

* Lyell, Rogers, Desor, &c.

not occur at a great altitude above the present sea-line, and in this deposit Mr. Baurman has also found marine shells.

Next in point of altitude, although probably altogether more recent than the first group, come the Lake terraces which surround Lake Superior and the upper part of the St. Lawrence Basin, at an altitude of from 500 to 800 feet. At nearly the same altitude fresh-water deposits are found in the Lake Winipeg Basin, showing that there also the lakes have decreased in size as their waters created channels of escape through the eastern belt of rocky country. These deposits form the level prairies round the Red River settlement, and constitute the first or lowest prairie steppe.

The belt of rocky country which divides Hudson's Bay from the St. Lawrence Basin, but is traversed by the rivers that flow from the Winipeg Basin, has an altitude in some parts of 1400 to 1600 feet, and its highest portions are covered by deposits of coarse sand with erratics. This drift deposit does not appear in situations only when sheltered by rocky high grounds, but forms a swampy or wooded plain, the eastern margin of which has been water-worn into deep gulleys and *pot-holes*, or circular depressions which have no outlet. The rock surfaces in this region are found to be furrowed by scratches which have a southerly trend.

Passing to the west across the low plains formed of the lake deposits which were before mentioned, we find that they are bounded to the west by an escarpment which marks the eastern limit of the second prairie steppe, which slopes from 1000 to 1600 feet above the sea-level, and is covered often to the depth of several hundred feet with drift similar in character to that that covers the eastern rocky district. The third prairie steppe, which bounds these heavy drift deposits to the west, ranges from 2000 to 3000 feet above the sea-level, and is composed of cretaceous strata, but still with a sprinkling of erratics on its surface. The escarpment which the third steppe presents is often an abrupt slope, 500 or 600 feet in height. It follows a line N.W. and S.E., which was seen well marked to the north of the Saskatchewan, and thence sweeping in the above direction with large bays and indentations, but keeping on the whole parallel to the rock tract to the east, and thus forming a trough, through which swept the currents that dispersed the erratics by means of icebergs.

In the centre of this trough there occur hills which are composed of masses of the cretaceous strata that have remained undisturbed, and which display the feature known as "Crag and Tail," having the one aspect, generally the N. or N.E., furrowed and water-worn, and covered with a profusion of boulders, while in the opposite direction they form a gently sloping plain comparatively free from erratics, the "tail" being in this case without loon blocks, owing to the soft nature of the "crag."

It is not improbable that the rate of elevation of the east and west sides of this trough has been unequal, for along the base of the escarpment that forms its western margin, enormous boulders of magnesian limestone are deposited at an elevation of not less than 648 feet above the sea, which so far as is known could only have been derived from strata which form the eastern floor of the trough at an elevation of not more than 800 feet.

Excepting the boulder clay mentioned as occurring on the Gulf of Georgia, the later deposits on the western slope of the continent are very different from those on the east, as they consist of well-worn shingle, with sand and calcareous clay filling all the valleys on both sides of the Rocky Mountains from an altitude of 5000 feet to the sea-level. These deposits have generally been moulded by lake and river action into terraces which skirt the valleys.

REVIEW.

Mineral Veins: an Inquiry into their Origin, founded on a Study of the Auriferous Quartz Veins of Australia. By Thomas Belt. London: John Weale, High Holborn.

In this pamphlet of five chapters, containing about fifty pages, Mr. Belt seems to imagine that he has solved the most complicated question within the whole range of geological science. It is difficult to know how to treat such an extraordinary pretension; for, while the writer is palpably incompetent to deal with the subject, he cannot be classed among those presumptuous *charlatans* who continually infest it, and who have succeeded, in no small degree, in rendering any discussion on the origin of metalliferous deposits distasteful to persons of sense or education. Mr. Belt is evidently a painstaking man; he has made himself acquainted with the best known elementary books on geology; he expresses himself in a becoming manner; and is doubtless a most worthy and highly respected person in his station in society. But these respectable qualities, although pleasing in themselves, and entitling their possessor to much personal consideration, do not constitute a man of science; they do not justify a person, wholly unacquainted with the great metallic mining districts in any part of the world, even in his native country (which, according to his own showing, is Mr. Belt's case), from dogmatizing on the entire phenomena of metalliferous veins from a cursory experience in the gold diggings of Australia. The humblest observer, provided he brings but *one* clearly-described and well-authenticated fact is welcome as a true labourer in the field of science; and if even upon this fact he should attempt to build an unwarrantable superstructure of theory, his weaknesses may fairly be treated with gentleness in consideration of the sterling coin—the fact—for which we are indebted to him. But Mr. Belt can plead no such palliation. In his whole pamphlet there is not a single new fact. From first to last it is a mere *plaidoyer* based on the most hackneyed statements of other writers—generally such as are so well known, and have been so often quoted, as to have become really nauseating, and which make Mr. Belt's pamphlet almost as disagreeable to read as the last *réchauffé* of any notorious book-maker—except that, happily, it is much shorter. The collation of observations and facts on any scientific subject, and the establishment of a theory founded on them, is, of course, a labour of great value; but then it can only be usefully undertaken when the facts and observations are sufficiently numerous and sufficiently well authenticated to afford a secure basis for generalization, which is not yet the case with our knowledge of metalliferous veins. The man who would undertake it must, besides, be a complete master of the topic which he attempts to handle on so large a scale. It may be pardoned in the mere observer to be imperfectly acquainted with the labours of others; he stands on an independent footing, and is a useful and worthy labourer as far as his own facts go, however generally ignorant he may be; but the man who, assuming a more ambitious position, and soaring from the *rôle* of a mere observer narrating his own facts and fitting them into others as best he can, into the character of a philosopher generalizing all known knowledge on any particular branch of science into a comprehensive theory, is not of the smallest value unless he is fairly competent for the wide task he sets himself up to perform; indeed, on the contrary, he generally does great harm, and is deserving of scant consideration.

If Mr. Belt had named his pamphlet after the title of a well-known popular work of fiction, and called it "Nothing New," he would have given the best idea of its contents. It would, therefore, be a waste of space, and an unfair infliction on our readers, to go seriatim through its pages. In a few words, we may say that Mr. Belt considers the auriferous quartz veins of Australia to be due to pure igneous action—to have been injected in a molten state as we now see them. The difficulties which every chemical geologist has suggested to this now entirely exploded view—of which it is only fair to say the writer has some notion—he sets aside, in a few off-hand sentences. The great questions of the comparative action of heat with regard to other agencies in the formation of the earth's crust, which are at present actively occupying the attention of the greatest living natural philosophers, he disposes of in a very summary manner—so summarily, in fact, that he may be said to "polish them off." He resuscitates that form of complacent sentence with which writers of former years were wont to dispose of any objection to the most ultra-igneous doctrines; and no doubt feels himself secure under this imitation of the style and views of eminent authorities. He should remember, however, that geology is the most progressive of sciences, and that what was considered very sound and orthodox a dozen years ago may, in the present day, be a gross anachronism; indeed, a more familiar acquaintance with the recent expressions of these eminent Nestors of our science, would have taught him that they are now content to express themselves in much more guarded language.

As ordinary metalliferous veins were evidently not injected in an igneous condition in the state we now see them, Mr. Belt accounts for this discrepancy between observed facts and his hypothesis by affirming that all the phenomena giving evidence of aqueous and other actions in veins, are due to causes subsequent to their origin, and thus disposes of these phenomena:—"having separated from the inquiry the facts due to secondary agencies, we find the residual phenomena strictly such as might have been produced by igneous action." Such is Mr. Belt's theory, according to which quartz gold veins are metalliferous veins in their normal unaltered condition, while ordinary metallic lodes are the same things altered by secondary action. We are not so very much surprised at such an extraordinary hypothesis from a man who has admittedly no knowledge of ordinary metalliferous veins; but may we not fairly ask how a man so unacquainted with his subject could feel justified in rushing into print upon it? The inspection of half a dozen Cornish lodes must have scattered such a theory to the winds; and surely if the subject was worth writing on it was worth this slight preliminary trouble.

As we have said before, we have no doubt Mr. Belt is a most painstaking man, and a highly respectable person, who expresses himself very decorously in an excellent imitation of the ponderous scientific style. But he is evidently a man of but one idea. He got the idea in Australia that quartz gold veins were easiest accounted for by assuming their igneous injection, and, in accordance with this assumption, he endeavours to compress the whole phenomena of metalliferous lodes, picking his data out of rather old books, a large proportion of which are no great authority themselves. In former days, we had "theories of the earth"—Huttonian theories, Wernerian theories—written exactly in this spirit, and we know how injurious their effect was on the progress of geology. In the domain of science, small men must, at least at present, be satisfied with the *rôle* of observers of facts; big men can alone usefully attempt to grapple general theories—even they often enough burn their fingers there. At any rate, before Mr. Belt again favours the world with his views on metalliferous lodes, or on gold quartz veins, we recommend him to see a lode—if it be only one—in some great mining district; and to study some recent and really valuable work on auriferous deposits, such as that of Oscar Lieber.

THE GEOLOGIST.

NOVEMBER, 1861.

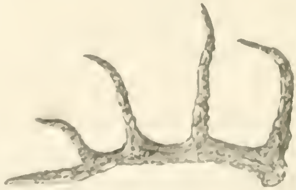
SOME BITS OF HORNS FROM FOLKESTONE.

By the Editor.

Old bones, that would be worthless to anybody else, become valuable to the geologist. There may be nothing picturesque or strikingly singular in their appearance. They may be too rotten or too fragile for the manufacturer; too sapless for the agriculturist; nay, too few or too far between to be of any commercial value at all. And yet *bits* of bones may be inscriptions of much value to the palæontologist. As every letter in the few lines incised on the famous Rosetta stone was a key to some passage in a forgotten language of the past, so every new bit of bone may be the key to some passage in that greater history of a greater past which geology unrolls. Many years ago—how time flies past—I met with a little patch of mammaliferous drift at Folkestone; I gathered every fragment of bone, every tooth, every shell, which the workmen's picks and spades exhumed, and most of what I could not determine myself at that time, Professor Owen, and my then living and active friend, Mr. Turner, looked over and named.

Amongst the bones I then collected were two of form to me before unknown, and which I often since brought back to mind. Two—both fragments of horns—flat at the basal part, perfectly round towards the tip; no goat, nor antelope, nor deer, that I knew, had horns like them; and so those fragments were laid aside (not carelessly) for future thought and comparison. Shortly since in walking through the gallery of the British Museum, I visited the cases containing deers' remains, and there, at once I saw, not the counterparts, but what seemed to me the fac-similes of my bits of horns.

The specimens referred to are those purchased about 1853, of the talented, but unfortunate Bravard, who was killed at the earthquake at Buenos Ayres a few months since. Bravard, as is well known, left France shortly after the memorable *coup d'état*, having been much mixed up with political matters; and the collection of Auvergne fossils which he, the Abbé Cloizet, and M. Pomel, had formed, were brought to England, and sold to the trustees of our National collection. The horns and bones of the deer I have referred to, have neither been figured nor described anywhere that I know of, and I believe the only right they have to their name is the inscription on the tablet on which they are placed, "*Cervus tetracroceros.* Brav." They are all from Pliocene deposits at Perolles, Puy de Dome. The principal specimens are four horns of more or less adult animals, each characterized by, when fully developed, at most four antlers, projecting in front and coming off from the horn remarkably direct, so as to form almost a right angle; a young horn, probably the second year's; some upper and lower molar teeth; portion of maxillary bone with a series of milk teeth; portion of left maxillary bone with the two last milk molars; penultimate upper left molar; portion of right ramus of lower jaw, with all the molars (three molars, three premolars) in situ; lower portion of femur; portions of tibiæ; left metatarsal; calcaneum; four astragali; piece of scapula; piece of humerus; and a portion of a sacral vertebra.



Horn of *Cervus tetracroceros*, Brav.; in British Museum.

In the same case is a portion of deer's horn from the mammaliferous crag of Norfolk, which is placed with these remains, but we doubt its identity. The horns of the *Cervus tetracroceros* are also characterized by a peculiar flatness, while the tip portions of the antlers are nearly or quite cylindrical. It was this feature which so much struck me in the Folkestone horns, and which is a character peculiar entirely to the *Cervus tetracroceros* and the rein-deer, *C. tarandus*, to which Mr. Waterhouse inclines to think the Folkestone fragments belong. The comparison of the horns of the large collection of recent individuals of the latter in the British Museum has been made, and certainly in some the *back* antlers present striking similarities. But the horns of the rein-deer are so extraordinarily various, that in the determination of mere fragments it is almost impossible to acquire anything like certainty. Moreover, in the fragments from Folkestone there is a peculiar sulcation, or deep grooving in the central part, which is seen in all the horns of the *Cervus tetracroceros*, but which I have not noticed in any rein-deer. Geologists might not hesitate to determine the species from such fragments, but no naturalist would. Still, we may be pretty certain that the Folkestone fragments are either *Cervus tetracroceros*, and so examples of a deer, of which the only known examples belong to a much older age—the Pliocene—than is usually assigned to the other mammals with which they were associated; or they are those of the rein-deer, examples of which, in a fossil state, are extremely rare in British deposits. Either way they are interesting and worthy of record.

Hundreds of fossils are thrown aside and forgotten, lost and destroyed, because their finders do not know *what* they are. Pleased am I that these bits of horns did not share such a fate, for their evidence is valuable. Lying in the same bed with bones of the primigenial ox and ancient mammoth, red deer, hippopotamus, and Irish elk, we can now add another rare species to the list, if not a new kind of deer, to the number of the great beasts of that remarkable age. And these bits of horn have thus proved worthy of their saving, as many more bits of fossils might have done, had their owners kept them till they found out what they were.

DEEP SINKING FOR COAL IN THE WYRE FOREST COAL-FIELD.

ADDITIONAL NOTES, BY GEORGE E. ROBERTS.

SOME other memoranda which I find among my papers relating to this work (for a section of which, with particulars of shaft-sinking, see "Geologist" of last month) may not be unacceptable to your coal-mining readers.

The spot where the shaft was sunk was 476 feet above the level of the Severn Valley Railway at Eymoor, and about 510 feet above the ordinary height of the River Severn, from which it was distant about two miles. The coal seam met with and worked at the depth of 176 yards, has in other parts of the coal-field a thickness of four feet. The colliers regard it as a Flying Reed (red?) coal. Two of the thin coal-seams afterwards sunk through were entirely made up of the remains of Sigillariæ; the coal, in consequence, was "long grained" and slaty. These Sigillarian coals have a considerable range through the Wyre Forest field, and in common with most of the other seams, crop out along the western border. At the Baginswood pits, in the north-west corner of the coal-field, the upper coal, two feet four inches in thickness, worked by hand-draw, being only ten yards from surface, is a most interesting seam, made up entirely of compressed Sigillariæ.

I have lately paid these pits a visit, and recommend any one who is studying the structure of this ubiquitous coal-plant to get a block of the Baginswood coal. At the Blakemoor and Gibhouse pits, in another part of the Wyre Forest coal-field, a layer of black slaty coal, half an inch in thickness, is seen to be wholly made up of the compressed spore-cases of Lycopodiacæ, probably belonging to Lepidodendron. Concerning these, Dr. Dawson, in his lately published supplement to "Acadian Geology," thus speaks, while relating their occurrence in the Lower Coal measures of Nova Scotia:—

"There are also immense quantities of spherical or flattened carbonaceous bodies, resembling small shot, which I at one time supposed to be spawn of fishes, but Dr. Hooker regards them as the spore-cases of Lepidodendra." (p. 41.)

The grey conglomerate (No. 53 of the sinkings) was a hard compact rock, made up of variously sized angular fragments of green and purple Cambrian Sandstones. This is the bed which lies immediately above the "thick" or ten-yard coal in South Staffordshire; but the place of that much-wished-for seam at Shatterford was taken by twenty inches of anomalous "black and pink ground," followed by 5 feet of coarse fire-clay containing very few plant-remains. The fire-clays sank through evidenced many distinct surfaces of estuarine jungle; but if forest-spoils were ever laid upon the argillaceous deposits, after floods swept them away; little remained to be changed into coal.

The basalt, which at last ended the work, and caused the abandonment of the enterprise, is a sub-crystalline greenstone, rudely columnar at its near-lying outcrop, and containing in places vertical series of spheroids, which show their progress of change, by compression in a heated state, into columns. It may be called a hornblendic greenstone. One interesting feature of it is the quantity of *unaltered* calcite it contains, disposed in embedded amorphous masses in some cases as large as an orange. Zeolitic crystals also occur in it. In the dyke, which is extensively quarried for nearly a mile, these features are well to be seen; but a visit should also be made to the northerly limit of the outburst, Munster's Hill, which the basalt has capped with "a wild-looking pile of rhomboidal rocks, intensely black and hard; a mass not concealed by dross and rubble, as at other parts of the line, but lying naked to the light, hid by nothing but the grey crust of lichens."* These amorphous, rudely-columnar masses have a great resemblance to those which cap the Titterstone Hill, and there form the "Giant's Chair."

I do not know of a wilder spot in Worcestershire than Munster's Hill. A clump of immense yews are rooted at the feet of the basaltic columns, and lie against them, clasping the rugged masses with brown gnarled arms as ancient-looking as the rock itself.

Comparison of the Shatterford basalt with that of Kinlet, four miles westward, is an instructive work. At the latter outburst the Plutonic rock is of the same general character, that of hornblendic greenstone, but it contains crystals of augite and many *vitreous* crystals of calcite; weathers white, and is rudely columnar, like the Shatterford rock.

ON THE DISTRIBUTION OF MASTODON IN SOUTH AMERICA.

By Charles Carter Blake, Esq.

One of the greatest and most significant laws which modern palæontology has unfolded to us, is that principle by which it is definitively ascertained that, as a general rule, the animals of the Post-Pliocene, and indeed all the later Tertiary ages, were restricted to the same great geographical provinces as their representatives in the existing fauna. Amongst the Pliocene Mammalia of South America, we find the same preponderance of the Edentata, the same family of prehensile-tailed Monkeys, and the same typical Llamas and Vicuñas, as we find in the present pampas of La Plata, forests of Brazil, or elevations of the Andes.

* Rocks of Worcestershire, p. 29.

But we also find animals which, from all our previous pre-conceived associations, we had considered peculiar to the old world. The Elephants, of which one species (*E. Africanus*) now exists in Africa, a second (*E. Indicus*) in India, and a third (*E. Sumatranus*) in Sumatra and Ceylon, apart from the extensive and widely-distributed evidences which we find of their fossil remains in Europe, India, China, and Australia, extended their geographical province in the later Tertiary age over the whole of North America. The species of elephant which we find in Siberia (*E. primigenius*) has also been found over the whole of the space lately marked on our maps as the United States. South of the 30th degree of N. latitude it however gives place to a totally different species of true Elephant (*Elephas Texianus*, Owen, *E. Columbi?* Falconer), the molars of which, by their less degree of complexity, were more adapted to triturate the soft succulent herbage of Texas and Mexico. Besides these true Elephants, there existed in North America many individuals of the genus *Mastodon*, to which the present communication more particularly alludes. The *Mastodon Ohioticus* of Blumenbach (*giganteus*, Cuv.) has been found in Post-Pliocene deposits in North America, while in the Southern part of that continent the two species, *Mastodon Andium* and *Humboldtii*, supposed to be distinct, are found in various localities, to which I shall more particularly allude.

The Editor of the 13th volume of the "Quarterly Journal of the Geological Society," page 291, states, that "the *Mastodon Andium* occurs in Peru, Chile, and Tarija; and that the *M. Humboldtii* occurs in Buenos Ayres, Brazil, and Columbia." He refers to Gervais and Laurillard as proofs of this statement. The reference to Tarija, however, is a slip of the pen, as Gervais, in Castelnau's voyage, identifies the species found there as *Humboldtii*. We have thus two species of Mastodon in South America; and it is alleged by Laurillard that the one (*Andium*) is confined to the elevated regions of the Cordillera de los Andes, and that the other (*Humboldtii*) is found in the watersheds of the Amazon, Orinoco, and La Plata. It will scarcely prove a matter of surprise to the philosophical geologist, that the species (*Andium*) which has the greatest vertical range should also have the greatest horizontal range in space. The *M. Andium* has been found at a further distance from the equator than any other Proboscidean quadruped in the southern hemisphere, excepting in Australia. At the lake Tagua-tagua, in about latitude S. 35 degrees, are found the remains of this animal, as well as of deer in great profusion. They have been described to the world by De Blainville ("Osteographie," art. *Elephas*), by Claudio Gay ("Historia Fisica y Politica de Chile," Mamalogia Fosil, plate 8), and by Mr. W. Bollaert, F.R.G.S. ("Geol. Journal," xiii. 1857, p. 291). It is a singular fact that the last writer should have been fortunate enough to discover the first elephantine remains in Texas, showing the furthest southern limit of the genus, *Elephas Texianus* in North America, and that he should also have been a witness to the furthest southern limit in Chile of the contemporary form, *Mastodon Andium*, in South America. The present polar limit of the Proboscidea is 32 degrees South; and we have evidence of an American Mastodon in nearly the same latitude. But, upon the supposition that the state of the South American continent was analogous to the existing one, ordinary readers can hardly realize the fact that a species of elephant should have existed amongst an assemblage of high hills, at an elevation of 2300 feet above the level of the sea. The numerous indications, however, of volcanic action in the neighbourhood of Tagua-tagua afford us a clue to explain the cause by which such alteration of the aspect of the country as has been manifestly produced, must have been occasioned. The fragments of bone which Mr. Bollaert was enabled to discover, consisted of portions of a femur and tibia; those which Don Claudio Gay figures, are the atlas, tibia, calcaneum, fourth metacarpal, and, finally, the almost entire mandible.

De Blainville is of opinion that evidence is wanting that the *Mastodon Andium* and the *Mastodon Humboldtii* are different species. Laurillard (D'Orbigny, "Dict. Hist. Nat.," art. *Mastodon*) denies this theory, and points out that the angle formed by the symphysis in *Humboldtii* is short, and otherwise differs from the same structure in *Andium.* I am aware of the fact that Cuvier founded the species *Humboldtii* upon a specimen alleged to be brought from Concepçion by Baron Humboldt, a place never visited by him; but I am inclined to think that some error or misapprehension exists as to this statement. The Andes at present act as an effectual barrier to prevent the migrations of large species of animals across them, and unless the upholder of the theory that the La Plata and Chile species of *Mastodon* are of the same species, accepts also the hypothesis of their existence in South America antecedent to the present disposition of the continent and upheaval of the Andes, he cannot hold the possibility of accidental migration of elephants over the snowy range. If, however, both *Andium* and *Humboldtii* are modified descendants of some original progenitor, which existed in South America before the upheaval of the Andes, the difficulty in some way disappears. But upon examination of the specimens of *Mastodon Andium* in the British Museum collection, the habitat from which they are undoubtedly derived is Buenos Ayres. I have no doubt whatever of the perfect accuracy of Mr. G. R. Waterhouse's statement as to their being geographically derived from that country, and I cannot close my eyes to the fact, that we have here evidence of the existence of *Mastodon Andium* in a spot in which Laurillard, who so confidently assigned the western side of the Cordilleras as its habitat, never dreamed.

Are the differences between *Andium* and *Humboldtii* of specific value? I think not. From inspection of a large series of teeth of *Mastodon longirostris* (*angustidens*) I can confidently declare that there is not greater difference between the teeth of *Andium* and *Humboldtii* than between the many varieties of the narrow-toothed *Mastodon.* When Cuvier founded the species *Humboldtii,* he thought that there was a difference of size between the molar teeth of the two species. This, when a larger series of specimens is examined, proves to have been an imperfect and erroneous induction. There is no appreciable difference between the two species in this respect. The alleged symphysial difference I cannot regard one of specific dissimilarity. The differences which we observe in the symphyses of the *Elephas primigenius* or in the *Elephas antiquus* are fully equal to those between the same bone in the two South American species. Specific characters can never be founded on parts which are so liable to adaptive change as the symphysial angle of a great trunk-bearing beast.

From a careful consideration, then, of the whole aspect of this question, I am of opinion that the species *Mastodon Andium* and *Mastodon Humboldtii* are not specifically distinct. The Guanaco which climbs the summits of Tupungato, Aconcagua, or Tata-Jachura, is the same animal as the Guanaco which manages to survive in the plains near Puerto Deseado, in Eastern Patagonia. I have already pointed out in your pages, in the "Geologist" for August, that the Tarija *Macrauchenia*, like that of Corocoro, was in all probability the same species as the *Macrauchenia* Darwin found at Port St. Julian. Professor Owen said a few weeks ago to the British Association:—"The cardinal defect of speculators on the origin of the human species is, the assumption that the present geographical condition of the earth's surface is antecedent to, or at least co-existent with, the origin of such species." The application of this erroneous mode of thought has been by no means limited to Ethnology, and it has been through an analogous error that the existence of two species of *Mastodon* in South America has been asserted, upon geographical grounds alone.

The conclusion which I would wish to impress upon the minds of your readers, is that one solitary species of *Mastodon* existed in South America during the Pliocene age. That the distribution of this species, for which the name of *Andium* is obviously inappropriate, and that of *Humboldtii* undeserved, took place long prior to the upheaval, through slow volcanic agency, of the Andes. This species, for which a more appropriate name might be suggested, flourished over nearly the whole of South America, and like the *Megatheria*, *Mylodons*, *Glyptodons*, *Macrauchenia*, and *Toxodons*, has passed away, and leaves no evidence to apprise the geologist of the former existence of elephantine animals in South America except a few scattered molars and vertebræ, brought down by alluvial deposits from the heights of the mighty mountains in which, possibly, further remains may be embedded.

I remain, Sir, your obedient servant,

CHARLES CARTER BLAKE.

SKETCH OF THE GEOLOGY OF BIARRITZ.

Chiefly drawn from a Thesis by Monsieur Joseph Delbos.*

MONSIEUR DELBOS, after much research, has determined that the cliffs at Bidart consist of the cretaceous rocks, and that these cease going northward towards Biarritz, and are succeeded by beds of the Lower Eocene. The very lowest of these, however, does not appear on the coast, namely, that which he designates as "Marnes à Terebratules." The first, which is found to the north, beyond the chalk formation on the coast, is a calcareous rock, containing a species of serpula. Mons. Delbos writes as follows :—

"I now propose definitely the following divisions for the nummulitic deposits of the basin of the Adour.

"3rd. Upper Series { 1st. Operculine free-stones.
2nd. Limestones with *Eupatagus ornatus*.
"2nd. Middle Series—Nummulitic limestone with *Serpula spirulæa*.
"1st. Lower Series—Clays with *Terebratula*."

M. Delbos then gives an explanation of his section of the coast, starting from the point *a*, and going northward.

"North of the mass of siliceous limestone, of which I have already spoken, and which belongs incontestably to the chalk formation, there is an extensive depression, occupied by sands blown in from the shore, and which interrupts the continuity of the escarpment for the distance of rather more than a quarter of a mile. Beyond this depression the cliff recommences, and from the point where it first appears abundant specimens of fossils characteristic of the nummulitic formation may be collected from a large fragment which lies detached at the foot of the cliff. (*Nummulina, Serpula spirulæa, Vulsella falcata*, &c.)

"Starting from this fallen fragment, the cliff is formed of a yellow limestone, somewhat sandy in its texture, in which here and there softer bands occur. These beds dip E.N.E. Further on, these yellow beds alternate with blue ones of the same texture; presently, their inclination suddenly changes, and they dip south at an angle of 25°, and this continues to the end of this part of the cliff, where the blue argillaceous beds gain the predominance. The calcareous rock has been worked in several quarries which have been opened in this cliff, and it affords a sufficiently good stone for rough building-purposes. It is rich in fossils; among the species which it contains, I may mention *Guettardia Thiolati, Serpula spirulæa*, &c.

* Theses presentées à la Faculté des Sciences de Paris pour obtenir le grade de Docteur es Sciences Naturelles. Par M. Joseph Delbos, Préparateur d'Histoire Naturelle à la Faculté des Sciences à Bordeaux. Soutennes le 4 Décembre, 1854.

"Facing this cliff, there are some rocks which appear above the sands of the shore; at first the yellow sandy limestone but just discovers itself above the surface of the sand, and here it contains the same fossils as the escarpment itself; but further on, and distant about 120 yards from the cliff, there rises a large wedge-shaped mass, named 'La roche pointue,' composed of yellow sandy limestone, and of white limestone containing *Nummulina spissa* and *Serpula spirulæa*.

"Another depression, traversed by the little stream which is designated 'Ruisseau du Moulin d'Estaigh,' again interrupts the continuity of the cliff. A sort of connexion between the two cliffs is kept up by a bluish argillaceous limestone containing many fossils,* and which appears here and there above the surface of the sand. * * *

"Continuing the examination of the cliff, beds of bluish clay are first observed, which dip at about 45° to the S.E.; these beds are alternated with narrow bands of limestone of the same colour, containing *Pygorhynchus sopitiamis*, &c. These beds soon become horizontal, and retain the same position to the end of the escarpment.

"The alternating beds of limestones are of a yellowish shade (see Sketch of cliff). These and the associated argillaceous beds become much disturbed and bent, then dip almost perpendicularly, and a little beyond the ophite rock, soon to be mentioned, entirely disappear under horizontal beds of alluvium.

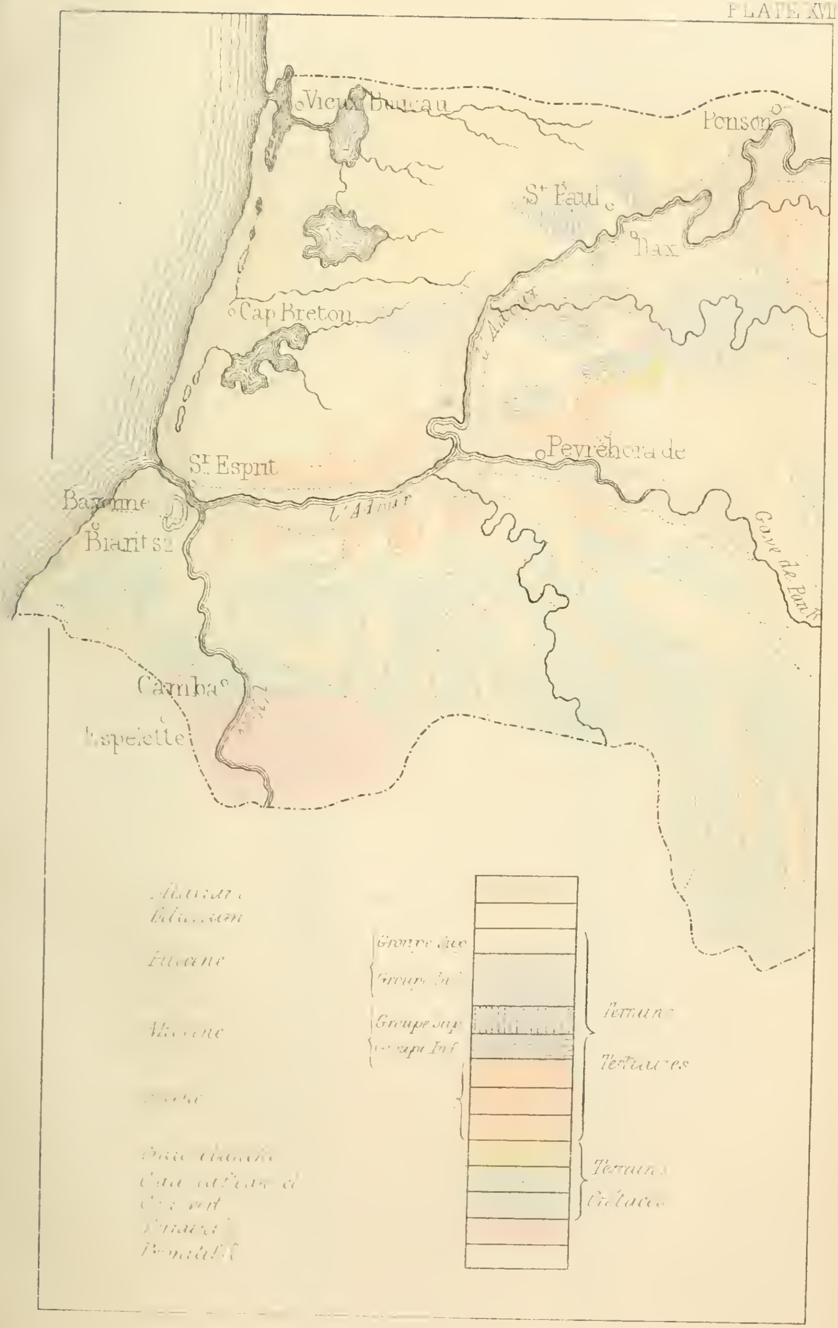
"It is precisely opposite this cliff that the large rock stands which is called 'La roche qui boit:' it is an enormous block, ten or eleven yards high, of extremely hard limestone, very white, and slightly saccharoid. The action of the waves has partially polished its surface; it contains an immense quantity of altered nummulites (*N. spissa*). The colour and the quality of this limestone, so unlike the rocks of the cliff, are due unquestionably to the influence of the ophite which appears about thirty-five yards south of the 'Roche qui boit,' under the form of a little rock, visible only at low water. This ophite is of a beautiful green colour, and has gained a fairly good polish under the action of the waves charged with sand, which beat against it perpetually. It is girdled at the distance of about twelve yards by a sort of semicircular belt of magnesian limestone, notched at its upper edge, blackish, and in some part red (also of a lovely grey), traversed by thread-like veins of sulphate of lime, hard enough to be partially polished. The seashore sand prevents the establishment of the connexion which exists between the ruptured beds of calcareous rock and the ophite."

Here M. Delbos omits entirely to mention that the remainder of this escarpment, till it sinks like the previous one, beneath drifted sand-hills, is composed of horizontal beds of modern deposit, from thirty to forty feet in elevation, and rich in vegetable matter. He continues thus—

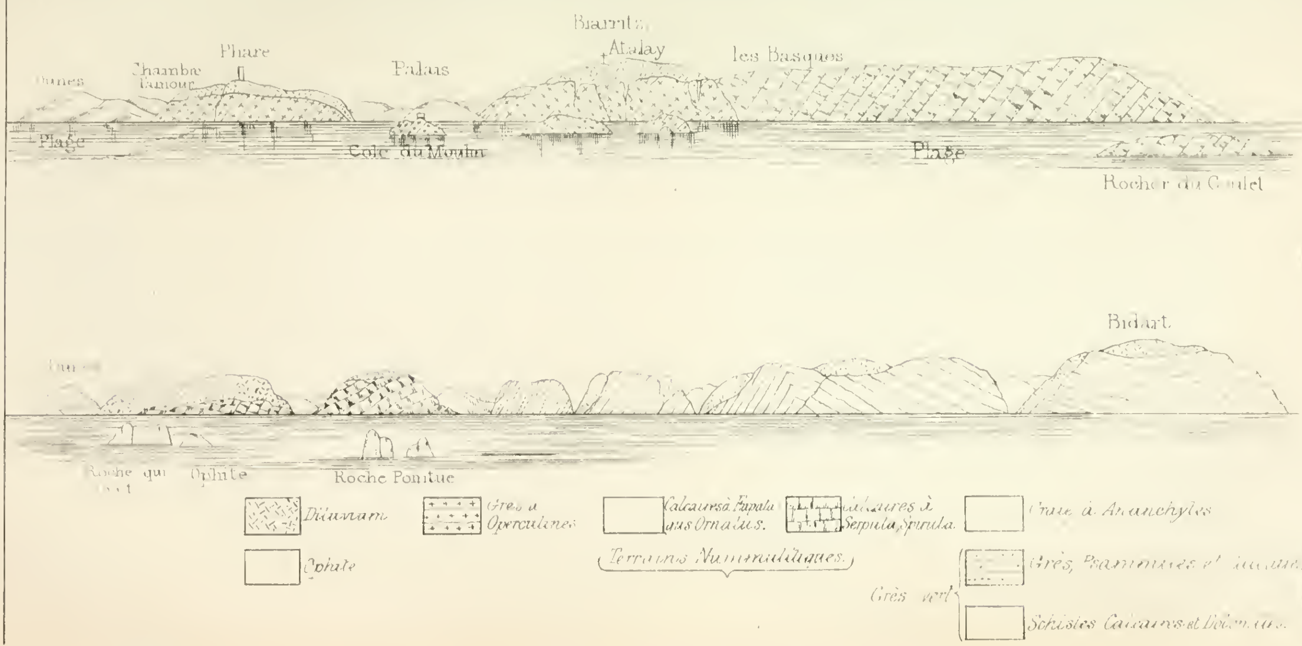
"Beyond the last-mentioned interruption in the continuity of the

* Among others, I have found here remains of a crustacean resembling a crab. —A. D. A.

PLATE XVII


Vieux Boucau
Ponson
St Paul
Dax
Cap Breton
L'Adour
Peyrehorade
St Esprit
Bayonne
Biaritz
Gave de Pau
Camba
Groupe Sup
Groupe Inf
Terrains
Tertiaires
Terrains
Crétacés

SECTION ALONG THE COAST NEAR BIARRITZ.



cliff begins a long rectilineal escarpment, which extends to the 'Port des Basques,' marked out with great regularity to the N.N.E., for the distance of rather more than a mile. Opposite the point where this cliff begins, there rises in the sea a rock much more considerable than those we have hitherto met with, and which is designated by M. Thorent the 'Rocher du Goulet:' it is formed of grey-blue limestone, tolerably hard, and worked as building-stone; it dips to the N.N.E., and encloses a great quantity of fossils." (This rock has been so much worked for building that it is below high-water mark, 1861.) "The cliff itself, throughout its whole extent, presents a very uniform appearance. It consists exclusively of alternate beds of bluish clay and soft limestone of the same colour, dipping regularly to the N.E. at an angle of about 40° or 45°. The only fossil found there is the *Serpula spirulœa*." (As you approach the Port des Basques, the beds become richer. On the shore, imbedded in the rock, I have found several varieties of shells, and also a good deal of wood.) "This long clay cliff terminates abruptly at the Port des Basques against the promontory of Biarritz.

"Here begins a new system of deposits, harder than those which we have hitherto described, and to this circumstance is due the singular aspect of the whole of this mass of rock, fantastically worn by the sea. * * * It is composed of yellow arenaceous limestones towards the south, intermingled with beds of arenaceous limestone of a bluish shade, which, advancing northward, become more and more abundant. These limestones enclose an enormous quantity of small nummulites (*N. intermedia*), which of themselves almost form small beds; the *Eupatagus ornatus* is also sufficiently plentiful; finally, round the 'roche percée,' the *Scutella subtetragona* is frequently met with; this fossil has, no doubt erroneously, been stated to be found in the Dax beds. * * *

"In the regular strata, rolled pebbles of hard grey subsaccharoid limestone, and also of black flint, may be frequently observed; they are the *débris* of the siliceous limestone of the chalk period, similar to those in the escarpment of Bidart, and which must have existed as rocks on the shore of the sea in which the nummulitic beds were in process of formation.

"The whole strata which form the mass of the rock at Biarritz are overlaid by a very modern deposit of yellow sand, which on the Attalay attains the thickness of at least fifteen or twenty yards. (This modern deposit beyond the Attalay, beneath the Empress's chapel, contains wood and great masses of vegetable matter.)

"Beyond the point of Biarritz begins the 'Côte du Moulin,' bordered at first by little escarpments, surmounted by some sand-hills. These escarpments are formed of a very sandy bluish limestone, with some yellowish bands containing an abundance of the *Nummulina Biarritziana*, also the *Eupatagus ornatus*, the *Schizaster rimosus*, &c. Low sand-hills occupy the space beyond, for a distance of 600 or 650 yards, after which follows a steep cliff, twenty-five or thirty yards high, composed of bluish sandy limestones, with some yellow bands, containing but few fossils (*Pecten*, *Ostrea gigantea*), and dipping to the N.E. at an angle of 25° or 30°.

"Below the lighthouse a very hard fine-grained limestone, or rather a calcareous freestone, presents itself intermingled with the other beds, and containing *Cytherea Vernenilii*, &c. Some deposits containing pebbles, ten or twelve yards thick, overlie the whole of these beds.

"Beyond the Point St. Martin begin the cliffs of the 'Chambre d'Amour.' They are formed of somewhat soft sandy limestones, with *Operculina*, *Ostrea gigantea*, and *Venus transversa*; here also may be observed the same beds of hard bluish calcareous freestone with Scalaria, &c., as those beneath the lighthouse. At the extremity north of the little bay, the hard freestone is scattered, as it were, through the softer sandy rock in the form of flattened detached nodules, disposed in somewhat regular beds. Advancing from the lighthouse, these nodules increase in volume and become blended together in more continuous masses, till at last they entirely replace the more friable rock, in which at first, beneath the lighthouse, they only partially appeared.

"The preceding description leads naturally to the following conclusions:—

"1st. The nummulitic strata of the cliffs of Biarritz dip regularly to the N.N.E., except for a short space where their inclination is in a reverse direction, opposite the ophite rock. Consequently, in following the coast-line from the commencement of the nummulitic cliff to the point north of the Chambre d'Amour, the strata are in regular sequence from the older to the more modern deposits.

"2ndly. From the commencement of the nummulitic cliff to the Port des Basques, there is a vast system of calcareous deposits, first arenaceous, afterwards argillaceous, and characterized principally by the *Guettardia Thiolati*, *Num. spissa*, *N. complanata*, *Serpula spirulæa*, &c. At the Port des Basques these beds disappear beneath the following deposits.

"3rdly. From the Port des Basques to the St. Martin lighthouse, that is to say, through the whole mass of the point of Biarritz, and a part of the Côte du Moulin, yellow or blue sandy calcareous deposits, with rolled pebbles of flint or limestone, follow the strata previously described. The fossils of the former beds are no longer found. Their place is taken by the *Eupatagus ornatus* and the *Nummulina intermedia*, which appear for the first time.

"4thly. Finally, from the lighthouse to the extremity at the Chambre d'Amour, a system of hard, fine-grained, calcareous freestone is developed, associated with Operculina sands. These rocks no longer contain the *Eupatagus ornatus*, nor the *Serpula spirulæa*, but they present a certain number of fossils, for the greater part identical with the species found in the Paris basin, and unquestionably characteristic of the Tertiary period. The Operculines seem here to replace the Nummulites."

* * * * * * *

The work from which I have quoted contains an elaborate account of all the formations of the valley of the Adour ; but I do not wish to extract details beyond those which relate to Biarritz.

With regard to the rich beds of well-preserved shells found near Dax, and in some other parts of the Landes, the same author places them in the upper beds of the Miocene.

He writes on this point as follows :—

"The shelly deposits of the Upper Miocene of the basin of the Adour are represented at three points—one is in the Commune of St. Paul, near Dax. * * *

"At St. Paul, the yellow sandy beds contain an enormous quantity of fossils, and crop out at a great number of points from beneath the sands of the landes." * * *

In the Upper Miocene of this region there appears to be one limited deposit, but a well-defined one, of fresh-water origin.

"Upper group, Sand of the Landes." This he places decidedly as the Upper Tertiary, or Pliocene.

He says, "This formation, which plays so important a part in the valley of the Adour, is, except towards the south, most uniform in its composition. It covers all the Marensin with a thick mantle, re-appears at the tops of all the hills, and on the central plateau of La Chalosse, and traverses the river-bed (*Gaul*), disappearing finally under the form of 'molasse and macigno,' beneath the diluvial deposits, from which it is often difficult to distinguish it."

Mons. Delbos' account of the diluvial drifts is very brief, and he makes no mention of the modern deposits, rich in vegetable remains, south of Biarritz. Near the ophite rock they form a cliff from thirty to forty feet high at least. They lie perfectly horizontal, and are composed of alternate beds of sand and gravel, the stratum of vegetable matter appearing at its base, just above the seashore sands.

Further on in his thesis, M. Delbos speaks of the Ophite. He says that in general fibrous gypsum is found near it, but that this does not appear to be the case at Biarritz.

Probably when M. Delbos examined this coast the seashore sands were rather higher opposite the Ophite rock than they are at present. Under the cliff, at about thirty yards from the Ophite rock, I found a very good example of the fibrous gypsum. It lay—as he states it generally does—"dans des argiles rouges." At the point where I saw it, the gypsum, not much more than an inch thick, lay imbedded like a wedge in clays of the most beautiful colours, veined grey, red, and yellow, and of the texture of stiff paste.

In conclusion, there seems to be little or no question that the Nummulitic rocks belong to the Lower Eocene period ; that is to say, to the Lowest Tertiary, and that in general they repose directly on the Chalk.

The researches of geologists seem to have established that the Nummulitic rock exists very extensively in Southern Europe. Mont Perdu, in the Pyrenees, is composed of it, and also La Montagne Noire de Corbières. On the south of the Pyrenees it extends from Vittoria into the valley of the Ebro. Again, in Languedoc and Dauphiné. Near Nice, in the Maritime Alps, and in Lombardy. In Switzerland, in Sicily, and in Turkey. Not to speak of Egypt, where this rock has long been known to exist.

A. D. Acworth.

NOTES ON THE GLACIAL PHENOMENA OF WASTDALE, CUMBERLAND.

By Edw. Hull, B.A., F.G.S.

Dear Sir,—I had hoped this year to have been able to extend over the Northern portions of the Cumbrian mountains some observations on Glacial Vestiges which I made in 1859 over the southern slopes of the same range, and communicated to the *Edinburgh New Philosophical Journal*.* I have only, however, been permitted to investigate a very small tract along the western slopes; but though limited to this, the following notes may not be without value, as there are few observations as yet recorded of the evidences of extinct glaciers in the English Highlands.

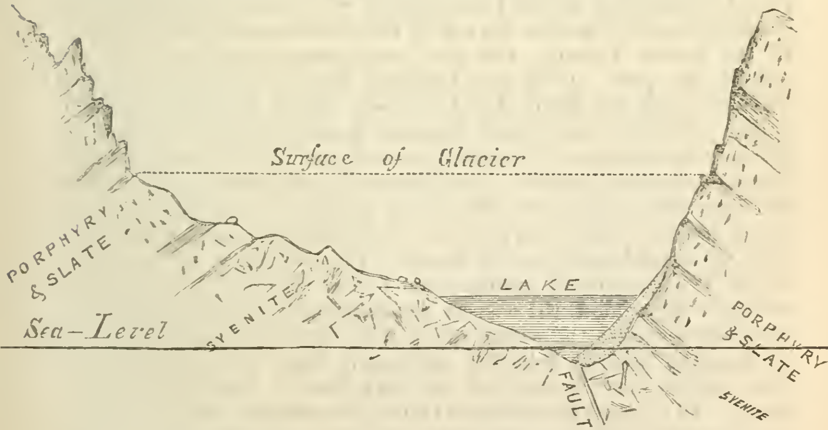
I may preface my remarks by observing that the first notices of glacial phenomena in the Lake district were made by Agassiz and Buckland in their general survey of the evidences of extinct glaciers in the British Islands; but they were accompanied by very few special examples. It is not, however, from any want of striking instances that till lately they have been passed by almost without notice. Every valley which descends from the central watershed, presents the features of a glacier-channel, and is well furnished with *roches montonnées*, perched blocks, moraines, and striated rock-surfaces. Even the lakes, which are the special feature of this region, are in many instances due to the presence of terminal moraines, which have acted as embankments to the waters. In addition to the instances which I have already enumerated, I may now add that of Wast Water, "the wildest, the deepest, the most impressive of all our lakes, over whose surface the winter's frost cannot spread a crust."

Wastdale leads up from the undulating tract of New Red Sandstone which lines the coast into the very heart of the highest mountains. At its head stands Great Gable, an elevation conspicuous for its pyramidal outline as seen from the west. On the right of this rises Scawfell, the culminating point of England, 3166 feet, throwing out some limbs, like great buttresses, with very gracefully curved

* Vol. xi. Glacial striæ have also been observed by Professor Phillips on the limestone of the southern coast, and by Mr. Bryce, near Kendal. In a letter to the author in 1860, Mr. W. Longman states how much he was struck by the glacial phenomena in several localities in the Lake district.

outlines. Its western shoulder forms "The Screes," a range of precipitous cliffs overtopping banks of shingle which sweep down in one sheer unbroken plane into the deep waters of the lake. The position of the rocks on each side of the lake, together with the straightness of the southern line of cliffs, are in favour of the supposition that Wastdale has been formed along the line of a great fracture. Yewbarrow, on the northern side, is one of the most picturesque hills I have ever seen. Capped by vertical cliffs, which ascend almost to a point, its sides fall away on either hand in exceedingly graceful outlines, to which I would draw the attention of Mr. Ruskin, as they illustrate his doctrine of the curves of nature. It is in vain for me to attempt to describe the various aspects which the landscape here assumes, with the most solemn and wild features she has also combined her most graceful proportions.

On my former visit to the Lakes, I became convinced that this mountain-chain had been a "centre of dispersion," from which glaciers descended in every direction seaward. In Grisedale, I had found striæ ranging north. In the neighbourhood of Ambleside, south and south-east; but I had never an opportunity presented of observing a westerly striation. I was therefore delighted (the less enthusiastic reader will, I hope, pardon the use of the only word expressive of my feelings on the occasion) on finding just above the village of Strands, near the western entrance of Wastdale, a boss of syenite polished, and distinctly marked with grooves ranging out to



sea. Further up the valley, I obtained at least six good observations, and the invariable direction was west, or nearly so. The highest observation was made on porphyry, near the foot of Yewbarrow.

The upper limit of the glaciation, along the centre of the dale, was easily ascertained. The rocks, from the edge of the lake up to an elevation of about 800 feet above its waters (estimated), were found to be all clearly ice-moulded, that is to say, worn down into smooth mammillated bosses, often showing striations or grooves ; but above this line, which appeared very constant for a long distance, the rocks assume the form of crags, sharp and precipitous. (See figure.) The contrast here alluded to may be well observed on the flanks of the rock-masses west of Greendale. And if we suppose that it marks the upper limits of the glacier, we have a measure of the thickness of the ice at this point. The level of the lake is 160 feet above the sea, and its depth 270 feet, or 110 feet below this. This would give for the total thickness of the ice 800 + 270 = 1070 feet, and for its surface, 800 + 160 = 960, or 1000 feet above sea-level. By similar admeasurements, it is probable the thickness of all the extinct glaciers may be calculated.* The length of the glacier (measured from its *nevée*, at Wastdale Head, to the point where the first traces of glaciation were observed) appears to have been upwards of six miles, and it had its source amongst the snow-clad heights of Scawfell, Yewbarrow, Kirkfell, and Great Gable. From these reservoirs also proceeded, in all probability, glaciers into Ennerdale, Crummockdale, and Borrowdale.

In Wastdale, there is a remarkable scarcity of some of the more prominent productions of glaciers, at least as compared with many of the neighbouring valleys. There is very little drift, or moraine matter, with one exceptional case presently to be noticed, and perched blocks are of rare occurrence. In general, the native rock is bare, but invariably iceworn from the water's edge up to the limit already assigned.

But the large moraine which has been thrown across the valley near its entrance, and which forms the embankment for the lake, amply compensates for the absence of these glacial monuments in other parts of the valley. Viewed from above, it looks like an artificial bank, as its upper surface has been levelled, and planted with trees. It is nearly 500 yards in length, with a breadth varying up to 100 yards, and a height of sixty feet above the surface of the lake. The water finds an outlet in a channel between the southern end of the moraine and the base of the Screes, which here tower aloft to a height of about 1000 feet, a wall of beetling cliffs. I satisfied myself, by a careful inspection, that this bank, to which the lake, at least partially, owes its existence, is a true terminal moraine. It is either this or man's work, and the latter it certainly is not. It is composed of gravel and sub-angular or rounded pebbles in a clayey matrix, also enclosing large blocks of porphyry and other rocks. To the south, it terminates, as already stated, opposite the base of the Screes, and its northern extremity reposes upon ice-moulded bosses of syenite. The period at which this moraine was thrown across the valley was probably that third stage in the changes of the Glacial Epoch, when, after

* Similar admeasurements have been made in North Wales by Professor Ramsay.—*Peaks, Passes, and Glaciers.*

the deposition of the Boulder clay around the flanks of the hills—to an elevation in Cumberland of about 1000 feet—the land was elevated, and glaciers again descended the valleys and "ploughed out the drift." It is only on such a supposition, as deduced by Professor Ramsay from his observations in North Wales, that we can account for the existence of old moraines at levels so far below that attained by the Boulder clay.

I remain, dear Sir, yours faithfully,

EDWARD HULL.

FOSSILS OF NORTH BUCKS AND THE ADJACENT COUNTIES.

By J. H. MACALISTER.

As the geographical distribution of fossils is always an interesting subject, it has occurred to me that a few words on the Oolitic fossils of this part of England, not much visited by geologists, may be acceptable to, at least, some of the readers of the "Geologist." It will not be my intention in this paper to treat so much of the geological features of the country, as to give complete lists of the organic remains which have been found by myself and a few others in the various strata of this district. The Oolites of North Bucks and Northampton, though of course presenting, for the most part, the usual character of the system as represented in other Oolitic districts of England (being, as they doubtless are, merely a continuation of those of Oxfordshire, &c.), yet possess several points of interest peculiar to themselves. The identity of the "Northampton Sands" (formerly classed with the Lias)* with the Stonesfield Slate of Oxfordshire and Gloucestershire, and constituting the Lower Zone of the Great Oolite, the importance of these "sands" as an iron ore; the occurrence of land-plants similar to the Stonesfield specimens in the *Forest-marble* of the neighbourhood of Wolverton; the extensive development of the *Kimmeridge Clay* at Hartwell; and of the *Great Oolite* further north;—all these facts combine to invest these beds with much interest, both to the geologist and the palæontologist.

The strata which I am about briefly to describe, and whose organic remains I shall enumerate, are the following:—

UPPER OOLITES.	MIDDLE OOLITES.
Portland rock.	Oxford clay.
Kimmeridge clay.	

* So classed by Dr. Wright, being separated by him from the Inferior Oolite, which they formerly were supposed to represent.

LOWER OOLITES.	LIAS.
Cornbrash.	Upper Lias clay.
Forest-marble.	Marlstone.
Bath Oolite.	Lower Lias.
Northampton sand.	

I cannot dwell on the lithology of these beds, which differ not in mineral composition from equivalent strata in other parts of England; but, before describing their fossil contents, I will content myself by just tracing the boundaries of the various divisions as I go on.

The Upper Oolites—*viz.*, the Portland rock and Kimmeridge clay—are greatly developed in the Vale of Aylesbury; that fertile tract of country lying between the Cretaceous ridge known as the East Anglian heights and the Oolitic hills of Oxfordshire. Hartwell and Stone (about two miles from the town of Aylesbury) are equally renowned for the beauty of their organic remains. The first for Kimmeridge clay, and the second for Portland rock fossils. As the clay and limestone are very useful for economic purposes, several pits and quarries are found in the neighbourhood. The Portland rock is capped by a thin layer of Purbeck stone with a subordinate band of carbonaceous earth, which represents the dirt-bed of the Isle of Portland. In the limestone, remains of coleopterous insects were found by the Rev. P. B. Brodie; with the exception of these fossils, which are now rarely met with, scarcely any others are found. The Portland rock, however, has organic remains in great abundance, but not of great variety: the following list will show the most common of them:—

	Arca.
Ammonites biplex, *Sow.* (*var.* rotundus)	Panopæa.
	Lucina Portlandica, *Sow.*
Pleurotomaria.	Pecten lamellosus, *Sow.*
Natica elegans, *Sow.*	Lima rustica, *Sow.*
Cardium dissimile, *Sow.*	Myacites recurva, *Phil.*
Trigonia gibbosa, *Sow.*	Ostræa expansa, *Sow.*
,, incurva, *Sow.*	Fossil wood, &c.

The Portland rock extends some way farther north than Stone, and finally disappears near Bletchley. The clay at Hartwell is of a dull leaden colour, and is very fossiliferous indeed. But the bituminous shales which occur in this formation in Dorsetshire have not been noticed here, though lignite is pretty abundant. The following is a list of fossils from the Kimmeridge clay of Bucks:—

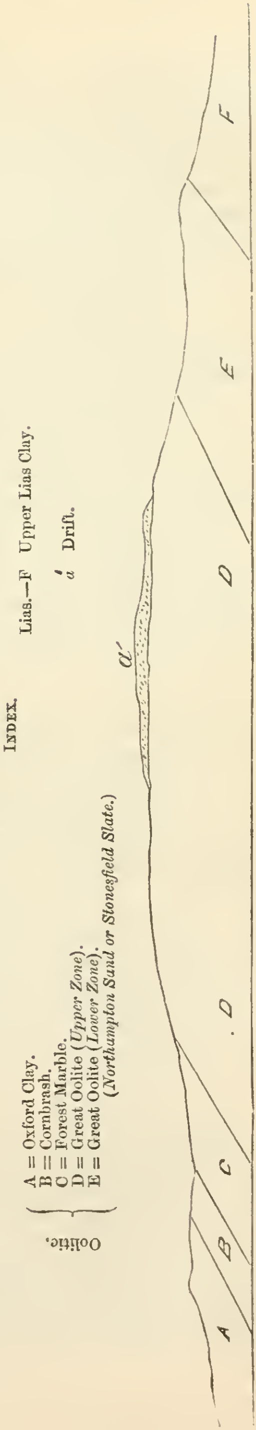
Ichthyosaurus, Plesiosaurus, Cetiosaurus, Pliosaurus — Bones, &c.	Ammonites biplex, *Sow.*
	Belemnites Owenii, *Pratt.*
	Pleurotomaria reticulata, *Sow.*
	Pholadomya æqualis, *Sow.*
	Myacites recurva, *Phil.*

Cardium striatulum, *Sow.*
Astarte lineata, *Sow.*
„ Hartwelliensis, *Sow.*
Thracia depressa, *Sow.*
Ostræa deltoidea, *Sow.*
„ læviuscula, *Sow.*
„ gregaria, *Sow.*
Pinna granulata, *Sow.*
Pinna.
Perna quadrata, *Sow.*
Trigonia costata, *Park.*
Modiola.
Panopæa.
Pecten arcuatus, *Sow.*
Pecten.
Serpula socialis, *Goldf.*
Gryphæa rostrata (?) *Phil.*
Trigonellites.

The extensive museum of Dr. Lee, of Hartwell Park, contains many beautiful fossils from the neighbourhood, and is well worth a visit. The fossils from the Kimmeridge clay are frequently sparkling with iron-pyrites; and thus they are almost unrivalled in beauty and delicacy; generally they are beautifully perfect and entire.

The Middle Oolite represented in this district merely by one member, *viz.* the Oxford clay, next makes its appearance. It is a bluish or leaden-coloured clay, sometimes laminated, and with frequent bands of concretions; it contains fewer fossils than any other formation in the district, with the exception of the Northampton sand, which has very few indeed.

In a former notice* I have briefly described the Oxford clay of the neighbourhood of Newport-Pagnel and Wolverton; so that very few words are here necessary. The most important point in its palæontology is the occurrence of marine reptiles (Ichthyosauri and Plesiosauri); the other fossils, with the exception of *Cerithium Damonis*, being common everywhere in this formation. This little shell,† which is tolerably abundant in the Oxford clay of Dorsetshire, but which, I believe, has not been found elsewhere,



SECTION FROM BEYOND WOLVERTON STATION TO HARPOLE, NORTHAMPTONSHIRE.

[Scale half-inch to a mile.]

* Geologist, vol. iv. page 214.
† Damon.

I have discovered in the Oxford clay at Newport-Pagnel. It is an elegant fossil, but by no means common.

Intercalated with the Oxford clay, in some places, there are fragmentary portions of a hard limestone containing several fossils, and among them *Rostellaria trifida* and *Ammonites Calloviensis*. This stone probably represents the Kelloway rock of Yorkshire, &c., but is rarely found in this part of England. The following is a list of the fossils which have been found in the Oxford clay of this district :—

Name.		*Locality.*
Ichthyosaurus communis, *Con.*	...	Newport-Pagnel.
Plesiosaurus	...	Little Lindford.
Ammonites Lambertii, *Sow.*	...	Wolverton.
,, Elizabethæ, *Pratt*	...	Newport-Pagnel.
Belemnites Owenii, *Pratt* ...	...	Wolverton.
,, breviatus, *Miller*	...	Stoke Goldington.
Rostellaria trifida, *Phil.* ...	...	Newport-Pagnel.
Cerithium....	...	Newport-Pagnel.
,, Damonis ...	...	Newport-Pagnel.
Ostræa gregaria, *Sow.* ...	...	Wolverton.
Gryphæa dilatata, *Sow.* ...	...	Wolverton.
Modiola imbricata, *Sow.* ...	...	Wolverton.
Thracia (?)	...	Newport-Pagnel.

In addition to these, I have found certain doubtful forms, probably opercula of some mollusc; also an abundance of lignite, and occasional impressions of small *cones* (?). The Oxford clay, flanked by the Lower Greensand and Gault on the one side, and by the Lower Oolites on the other, extends on towards Cambridgeshire and Hundington in a north-easterly direction.

Next in order appears the Cornbrash, which is but insignificantly represented. It consists of yellowish white limestones very full of fossils. The principal localities for these are near Stoney-Stratford (where, as Mr. Brodie informs me, he observed many corals), Wolverton, Olney, and the neighbourhood of Northampton ; also Gayhurst (Bucks), where several fossils have been found. A very common shell here is *Astarte aliena*; also a small species of *Trigonia*, probably *T. impressa*, which is also found near Wolverton. The following fossils were also found :—

Name.		*Locality.*
Pycnodus (teeth of) ...	...	Gayhurst.
Nucleolites clunicularis, *Llhwyd*	...	Gayhurst.
Holectypus depressus, *Lam.*	...	Gayhurst.
Diadema Bakeriæ, *Wright*	...	Northampton.
Ostræa gregaria, *Sow.* ...	...	Common everywhere.
Panopæa (a long species)	...	Gayhurst.
Modiola imbricata ...	...	Rowley pits.
Lima duplicata, *Sow.* ...	...	Gayhurst.
Mytilus sublævis, *Sow.* ...	..	Gayhurst, Grendon.

Name.	*Locality.*
Cyprina (?)	Gayhurst, &c.
Natica	Gryhurst.
Placunopsis socialis, *Lye.* and *Mor.*	Gayhurst. &c.
Nerinæa Goodhallii, *Sow.* ...	Gayhurst.
Opis sinualis, *Desh.*	Gayhurst.
Astarte aliena, *Phil.*	Gayhurst.
Terebratula obovata, *Sow.* ...	Gayhurst.
„ maxillata, *Sow.* ...	Gayhurst.
„ digona, *Sow.* ...	Yardley, Hastings.
Isocardia concentrica, *Sow.* ...	Gayhurst.
„ minima, *Sow.*	Gayhurst.
Trigonia impressa, *Sow.*	Wolverton, &c.
„ costata, *Park.*	Gayhurst.

Next we find the Forest-marble, consisting of hard blue limestone and clay, which, as it possesses land-plants, is of more interest than the Cornbrash, which is much the same as elsewhere. The Forest-marble does not in the least resemble the Stonesfield slate, as that of Gloucestershire does, in lithological character, not being flaggy or splitting into thin plates; but is a massive and very hard limestone, and very intractable. It is well developed around Wolverton station and town; and the following fossils have been obtained from it:—

Name.	*Locality.*
Pycnodus parvus, *Ag.*	Rowley pits.
„ Bucklandii, *Ag.* ...	Rowley pits.
Strophodus tenuis, *Ag.*	Rowley pits.
Terebratula maxillata, *Sow.* ...	Long-Street.
„ intermedia, *Sow.* ...	Wolverton station.
Rhynchonella tretrahedra, *Sow.* ...	
Astarte	Rowley.
Trigonia Moretonis, *Lyc.* and *Mor.*	Rowley.
Modiola imbricata, *Sow.*	Long-Street.
Myacites calceiformis, *Phil.* ...	Rowley pits.
„ recurva, *Phil.*	Wolverton.
Cardium Buckmanii, *Lyc.* and *Mor.*	Wolverton.
Natica	Haversham.
Ostræa gregaria, *Sow.*	Plentiful.
Nucleolites solodurinus, *Ag.*	Yardley, Hastings.
Spines of Echinites	Rowley.
Thuytes cupressiformis, *Brong.* ...	Wolverton.
Thuytes	Wolverton.
Wood and cones	Newport-Pagnel.

The coniferous plants were found between Wolverton station and Laughton, on the cutting of the London and North Western Railway, or rather in the stone blasted for the purpose of building a bridge over the line. We also find the coniferous wood near Newport-Pagnel associated with Terebratulæ, &c.; but frequently the fossils are in a fragmentary state and not easy of identification.

We now come to the Upper Zone of the Great Oolite, which attains by far the greatest development of any formation in the district, and by far the largest number of organic remains, as the following list will testify. It consists, throughout, of hard white limestone, freestone, and blue clay. The freestone is used for building and other economic purposes, and when in this form, the Great Oolite exactly corresponds with the "Bath Oolite," having just the appearance of that stone as seen in the vicinity of Bath. The Upper Zone of the Great Oolite extends over a large tract of country, and is in many places of considerable thickness, and has a general dip towards the east. As it is found in large massive blocks, in most places, it is, unlike the Cornbrash and Forest-marble, well adapted for building and other purposes; consequently there are many more quarries opened in it than in the above-mentioned formations.

Fossils from the Great Oolite (*Upper Zone*).

Name.	*Localities.*
PISCES.	
Hybodus grossiconus, *Ag.* ...	Gayhurst, Bucks.
Pycnodus parvus, *Ag.*	Horton, Gayhurst, &c.
„ Bucklandii, *Ag.* ...	Piddington, Gayhurst, &c.
Strophodus magnus, *Ag.*	Gayhurst, Horton.
„ tenuis, *Ag.*	Gayhurst.
Sphærodus	Piddington, Northants.
Strophodus reticulatus, *Ag.* ...	Ravenstone, Bucks.
CEPHALOPODA.	
Nautilus Baberii, *Lyc.*	Gayhurst quarry.
Nautilus striatus, *Sow.*	Ekely, Gayhurst, &c.
GASTEROPODA.	
Bulla undulata, *Bean*	Gayhurst quarry.
Natica Verneulii, *Arch.*	Near Ekely lanes.
„ Sharpei, *Mor.* and *Lyc.* ...	Piddington, Gayhurst, &c.
Natica, sp.	Gayhurst.
Nerita hemispherica, *Lyc.* and *Mor.*	Gayhurst quarry.
Pleurotomaria (small species) ...	Denton, Northants.
Nerinæa	Common.
Trochus squamiger, *Lyc.* and *Mor.*	Ravenstone, Bucks.
Trochotoma obtusa, *Lyc.* and *Mor.*	Ravenstone, Bucks.
CONCHIFERA.	
Myacites decurtata, *Goldf.* ...	Gayhurst quarry.
„ calceiformis, *Phil.* ...	Denton, Northants.
„ recurva, *Phil.*	Piddington, Northants.

Name.	*Localities.*
Pholadomya deltoidea, *Sow.* ...	Near Ekely lanes.
„ Heraultii, *Ag.* ...	Blisworth, &c.
„ æqualis, *Sow.* ...	Stoke Goldington.
„ Murchisoniæ, *Sow.* ...	Piddington, Ravenstone.
Modiola imbricata, *Sby.* ...	Ekely, Long-Street.
„ bipartita, *Goldf.* ...	Weston, Olney, &c.
„ gibbosa, *Sow.*	Denton, Northants.
Isocardia concentrica, *Sow.* ...	Near Ekely lanes.
Pinna ampla, *Sow.*	Woolaston, Northants.
Pinna.	Hantwell, Northants.
Trigonia costata, *Park*	Denton Stone pits.
Cardium globosum, *Bean* ...	Ekely, Bucks.
„ dissimile, *Sow.*	Bullington, Bucks.
„ Buckmanii, *Lyc.* and *Mor.*	Culworth, &c.
Ceromya similis, *Lycett*	Culworth, Northants.
„ concentrica, *Sby.* ...	Culworth, Northants.
Lucina Bellona, *D'Orb.*	Ravenstone, Ekely.
Arca	Several localities.
Hinnites velatus, *Goldf.* ...	Culworth.
Lima duplicata, *Sow.*	Gayhurst, Ekely.
„ impressa, *Lyc.* and *Mor.* ...	Denton, Gayhurst.
„ proboscidea, *Sow.*	Fragments in several places.
Gryphæa subloba, *Dest.*	Culworth.
Pecten lens, *Sow.*	Ekely, &c.
„ vagans, *Sow.*	Ekely lanes.
„ arenatus, *Sow.*	Near Ekely lanes.
Ostræa Sowerbii, *Mor.*	Blisworth, Olney, Stoke.
„ acuminata, *Sow.*	Ekely, Blisworth.
„ gregaria, *Sow.*	Salcey Forest, Blisworth, &c.
BRACHIOPODA.	
Rhynchonella concima, *Sow.* ...	Culworth, Blisworth, Ekely.
Terebratula maxillata, *Sow.* ...	Common everywhere.
„ digona, *Sow.* ...	Yardley, Hastings.
„ intermedia, *Sow.* ...	Piddington, Culworth, Gayhurst.
„ obovata, *Sow.* ...	Gayhurst, Denton.
„ sphæroidalis, *Sow.* ...	Gayhurst, Piddington, &c.
ECHINODERMATA.	
Acrosalenia Lycettii, *Wright* ...	Gayhurst quarry.
„ hemicidaroides, *Wright*	Gayhurst, Roade, Blisworth.
„ pustulata, *Forbes* ...	Blisworth, Culworth.
„ spinosa, *Ag.* ...	Culworth.
Hemicidaris Wrightii, *Forbes* ...	Stowe, Northants.
Nucleolites orbicularis, *Phil.* ...	Gayhurst, Denton, &c.
„ solodurinus, *Ag.* ...	Yardley, Ekely.
„ clunicularis, *Llhwyd* ...	Denton, Gayhurst, &c.
„ sinuatus, *Aust.* ...	Gayhurst.
„ Woodwardii, *Wright* ...	Middleton.

Name.	*Localities.*
Echinobrissus Griesbachii, *Wright*	Blisworth.
Clypeus Plotii, *Klein*	Blisworth, &c.
,, Mülleri, *Wright*	Gayhurst quarry.
Corals, various.	Blisworth, Woolaston, &c.

Many of the mollusca occur merely in the form of casts; some however, are well preserved, and generally entire; but on the weathered sides of many blocks of Great Oolite, portion of shells, plates and spines of Echinites, star-like portions of the stems of Pentacrinites, together with worm-tracks and Serpulæ, are common enough. In many of the quarries, before reaching the good workable beds of freestone or hard limestone, a marly bed has to be cut through: this bed is full of shells and *Nucleolites clunicularis* and other echinoderms. In a word, the Great Oolite is by far the most fossiliferous formation of the district. Though this is its general character, yet miles in extent of hard bluestone, with scarcely a vestage of a fossil, save at most a few oyster shells, extends over the high ground east of Road station; and what few fossils there are, are usually in a fragmentary state, bearing evidence of having been drifted by currents.

The Lower Zone next claims our attention, "the Northampton sand" equivalent, as I before stated, with the Stonesfield slate, but remarkably opposite to that formation in one respect, namely, that whereas that is full of organic remains—plants, molluscs, echinites, and fish,—this can scarcely boast of more than a dozen species (found at least as yet). The Northampton sands consist of ironstone, sands, sandstones, and slaty limestones, spreading over a large tract of country west and south-west of the town of Northampton.

The Northampton sands are used as an iron ore to a great extent, as they are peculiarly rich in the hydrated oxide: 74,084 tons of this ore were raised in the year 1855, and sent into Staffordshire to be smelted; but since that time furnaces have been erected near Weedon for smelting. The flaggy Oolitic stone belonging to this formation greatly resembles in appearance the Stonesfield slate, and what organic remains have been found, resemble those of Stonesfield still more closely than those of the Lias or Inferior Oolite. Although allied to the Great Oolite, there is no passage between them, but the sandstone rests on the Great Oolite quite unconformably.

LIST OF FOSSILS FROM THE NORTHAMPTON SAND.

Name.	*Localities.*
Megalosaurus Bucklandi, *Mey.* ...	Duston stone pits.
Bones of Dinosauria	Duston stone pits.
Belemnites compressus, *Sow.* ...	Duston stone pits.
Cardium Buckmanii, *Lyc.* ...	Duston.
Hinnites velatus, *Goldf.* ...	Duston.
Pecten (small sp.)	Duston.
Trigonia Moretonis, *Lyc.* and *Mor.*	Duston, Danes' Hill.
,, costata, *Sow.*	Gayton, Danes' Hill.

Name.		*Localities.*
Natica elegans, *Sow.* ...	...	Gayton.
Lithodomus inclusus, *Phil.*	...	Gayton.
Pteroperna marginata, *Lyc.*	...	Danes' Hill.
Gervillia acuta, *Sow.* ...	...	Danes' Hill, Gayton.
Astarte	...	Gayton, Duston.
Ostræa	...	Danes' Hill, Gayton.
Lima impressa, *Sow.* ...	...	Gayton.
Pecten vagans, *Sow.* ...	...	Duston.

The Northampton sand lies immediately above the Upper Lias clay ; but as the three members of the Lias developed in this district do not differ much, either in lithological character or in that of their fossils, from the equivalent strata elsewhere, and as I have already taken up, I fear, much valuable space with what I have already stated, I must content myself by enumerating the most characteristic fossils of the Lias without giving any description of the strata themselves. I may add, that most of these fossils from the Lias were found by the collectors of the Government Survey last year.

Fossils from the Lias.—Upper Lias Clays.

Name.		*Localities.*
Ammonites serpentinus, *Rein.* ...	...	Eydon and Kingthorn Northants.
,, Rauquinianus, *D'Orb.*	...	,,
,, bifrons, *Brug.* ...	...	,,
,, Hollandrei, *D'Orb.*	...	,,
Belemnites breviformis, *Voltz.*...	...	,,
Leda ovum, *Sow.*	...	,,
Myacites unionides, *Ag.* ...	...	,,

Ichthyosaurus communis, *Con.*

Marlstone.

Ammonites Normianus, *D'Orb.*...	...	Milton and Brockall.
Rhynchonella tetrahedra, *Sow.* ...	...	,,
Terebratula Edwardsii, *Dav.* ...	...	,,
Pecten cingulatus, *Goldf.* ...	...	,,
Lima punctata, *Sow.*	...	,,
Cardinia crassissima, *Stuch.* ...	...	,,
Myacites unionides, *Ag.* ...	...	,,

Marlstone at Hellidon.

Ammonites falcifer, *Sow.*
,, annulatus, *Sow.*
,, Hollandrei, *D'Orb.*
,, communis, *Sow.*
Terebratula punctata, *Sow.*
,, resupinata, *Sow.*
Rhynchonella tetrahedra, *Sow.*

The fossils of the Lower Lias Clay are not very plentiful; and the course of this clay is much hidden by drift; such shells as *Rhynchonellæ*, &c., are not, however, uncommon.

CORRESPONDENCE.

THE LUNAR SEAS.

To the Editor of the Geologist.

SIR,—When I commenced reading the first article in the last (the October) number of the GEOLOGIST—namely, that headed, "What has become of the Lunar Seas?" I expected to find that some attempt would be made in it to show that it was, at least, probable that seas did formerly exist on the surface of our satellite; and since astronomers concur to tell us that the moon is destitute of water, I cannot but think the expectation a reasonable one. But, reasonable or otherwise, it was doomed to disappointment, as the existence of such seas is quietly assumed, not only in the titular question but also throughout the paper. Thus we have (page 409), "When we look up to the moon, what do we see? Great ocean cavities and no water in them." (Page 410), "They do not tell us what *has become of the water* that once *was* in them," i.e., the so-called Lunar Seas. (Page 412), "*Then*" (when the moon was further from the earth) "it was it had its atmosphere and its ocean." (Page 414), "Doubtless the moon had once ocean and air," and "One thing, however, is certain, there are waterless ocean cavities on the moon." Now, I confess I should like to have some reason for the belief that any of the "waterless" cavities on the moon were ever "*ocean* cavities," or that at any time "the great *Oceanus Procellarum* was a rolling sea, and the *Mare Serenitatis* lay glittering under the golden streaks of our earth's bright beams," before even *speculating* on the question, "What has become of the Lunar Seas?"

But waiving this point, and assuming that there *were* formerly "Lunar Seas," on the simple grounds that, as Sir John Herschel tells us, "there are large regions perfectly level, and apparently of a decided alluvial character in the moon."* Why is it "of no use to say it is ALL gathered up on the other side"? A statement of the basis of this inutility would have been acceptable; some reply to the reasoning of Sir John Herschel on this point, for example.† Should we not be informed why "we cannot believe *that*?" Possibly, however, the basis of our alleged incredulity is supposed to be containe l in the next passage. "The moon always presents one side to our earth, and therefore her ocean waters ought to be drawn up on this, and not the other side." Unfortunately, however, the fact stated will not carry the inference placed upon it. Even if the moon had been a perfect sphere, with its geometric centre coincident with its centre of gravity—which has been doubted—and having water distributed over its surface without any marked preference for either hemisphere; all other things being as now, *the earth's attraction* could not draw, or have a tendency to draw, her ocean waters all up on the side always presented to the earth; at most it could produce two oceanic protuberances diametrically opposed, one on the point of her surface nearest the earth, and the other at that most remote from it; in fine, two high water points, which, omitting the *librations* of the moon, would be stationary; since, in that case, the earth would appear immovably fixed in the heavens, as seen from any point on the moon's surface. Whilst, if the moon were so constructed that all her waters *were* gathered up on that side always turned away from us, the attraction of the earth would only

* "Outlines of Astonomy," 5th Edition, Par. 430.
† "Outlines," 5th Edition, Par. 436 *a*.

have the effect of slightly helping to keep them there, certainly not to transfer them to this side; and this not because of the intensity of the earth's attraction on the moon, but because of the *difference* in this intensity as exerted at her centre and at the surface remote from us; such *difference* enabling the earth to pull her satellite slightly away from the water on the remote surface.

But to proceed. Supposing it to be a fact that "we cannot say there is not a residual balance in favour of approach" (of the moon to the earth). Is it not making an unusually bold use of inability to infer from it that there *is* such a balance? But waiving this point also, and assuming, for the sake of applying a test to the *speculation*, that the moon "has once been farther off—very much farther off," it by no means necessarily follows that she has ever yet come "sufficiently within the influence of the earth's attraction" for "the waters of the moon to be transported to our globe." According to the hypothesis, the moon is at present nearer to the earth than at any former period, and, therefore, nearer than at the time of the deluge of the "*speculation*." Now there can be no great difficulty in determining whether the thing could happen at the present distance; that is, whether the earth's attraction on a body on the moon's surface, placed in the straight line joining the centres of the two globes (the most favourable position for the success of our world in the struggle), would be greater or less than the moon's attraction on the same body. In short, Is the earth's power, at present, to steal a "Lunar Sea" greater or less than the moon's power to keep it? If less now, then, *a fortiori*, according to the hypothesis, it must have been less in all former periods.

Let E be the earth and M the moon, A B the line joining their centres A and B, and C a body on the moon's surface in the line A B. Now the attraction of a body varies directly as its mass and inversely as the square of its distance from the body it attracts; such distance being measured from centre to centre.

Putting the earth's radius = 1, the distance of the centres is 60·2734, and the radius of the moon ·2729; hence the distance of the body C from the seat of the moon's attraction is, on this scale, = ·2729, and from the centre of the earth = 60·2734 — ·2729 = 60·0005.

Also, taking the mass of the earth as unity, that of the moon is ·011364.

Then, if A and A′ represent, respectively, the attraction of the earth and moon on the body C, we have

$$A : A' = 1 \times \cdot 2729^2 : \cdot 011364 \times 60 \cdot 0005^2$$
$$= \cdot 0744744 : 40 \cdot 89375$$
$$= 1 : 549 \cdot 12.$$

That is, in round numbers, the earth attracts the body 550 times less than the moon does; or whatever inclination our attractive influence may give a "Lunar Sea" to precipitate itself on us, the moon gives it 550 times greater inclination to stay at home; and according to the hypothesis, this disparity of inclination was still greater in earlier times, and the more so in proportion to the antiquity of the time.

But suppose the organ of Stay-at-home-ness—I think the phrenologists call it "Inhabitiveness"—to be so feebly developed in a "Lunar Sea," that it *would* proceed on its travels, is it certain that it would go to the earth? Why not to the sun? We are told (page 414) that "it is not likely." So I think. But let us see whether the earth or sun would hold out the greatest attractions at present for a "Lunar Sea" on its travels. It is simply the question, which of the two bodies attracts the moon most powerfully?

Let S, E, and M be the sun, earth, and moon respectively; and the last in conjunction with the first, as seen from the second. It will be sufficiently accurate for our present purpose to take the distance of the centres of the earth and moon as = 60 radii of the former body, the distance of the centres of the sun and moon

as = 23,984 times the same unit, and the mass of the sun at 359,551 times that of the earth; then, putting S and E to represent the attractions of the sun and earth on the moon, respectively, we have

$$
\begin{aligned}
S : E &= 359551 \times 60^2 : 1 \times 23,984^2 \\
&= 80899 : 35952 \\
&= 9 : 4 \text{ nearly.}
\end{aligned}
$$

So that the sun's claim to a visit from a "Lunar Sea" is greater than the earth's in the ratio of 9 to 4; and if the moon, according to the hypothesis, were formerly farther from the earth, she would be, by so much, nearer to the sun, when in conjunction; and hence the attraction of the earth on the moon would be less, and that of the sun greater, at all earlier periods.

Apologizing for the length of this letter, I am, yours, &c.,

Torquay, Oct. 12th, 1861. WILLIAM PENGELLY.

To the Editor of the Geologist.

SIR,—Although the subject of the introductory paper of the October number of your justly popular journal more properly belongs to the science of Astronomy than Geology, yet, as some few of your many readers may be led from it to form unjust views of a by no means improbable reason which has been assigned for the absence of both air and water in appreciable quantities in that portion of the moon's surface which has ever been subjected to our observation, I think I may be excused for offering a few remarks on this subject, more especially as they may suggest an answer to the query propounded, "Seeing there are waterless *ocean* (!) cavities on the moon, where have these waters gone to?"

It has long been a well-ascertained fact that the moon rotates on her axis, and performs her revolution round the earth in the same period of time; it is also well known that if a stick loaded with a heavy weight at one end and a light one at the other be swung round by means of a string attached to the centre of this stick, that the heavy end will in the circulation assume a position further from the hand than the light one (see Herschel's *Outlines of Astronomy*, last edition, chap. vii.), hence it has been suggested by Professor Hansen, that the same cause which makes the heavier end of the stick describe the larger circle may in all probability be the reason why the moon always presents the same, or at least very nearly the same face to our earth, or, in other words, why the time of rotation on her axis and revolution round our earth coincide, namely, that in the moon, as in the stick, the centre of gravity does not coincide with the centre of symmetry. Let us now see what effect this would have on the distribution of water and air on the surface of a globe, as, although neither our moon nor the earth are truly circular, the difference of the effect produced in a globe of exactly the same figure as these bodies would be so small as in no way to affect the truth of our deductions or their applications; then, first, let us take the case of a globe (fig. 1), in which the true centre, or centre of symmetry, and the centre of gravity coincide. In this case supposing the surface of the globe to be smooth, it would be surrounded by a stratum of water, B, of equal depth all over, and this again by an atmosphere also of equal depth. As soon, however, as the smooth surface gets broken up and converted into heights and hollows, the water would betake themselves to the lower parts—that is, the parts nearest the centre of gravity—leaving the higher or more distant parts dry, these again covered with an atmosphere now of unequal depth, this varying with the height, that is, the distance from the centre of gravity of the different parts of the surface. This may be said to be almost the condition of our earth, varied by tides in the sea, and winds, &c., in the atmosphere: the cause of these is no subject for discussion here. Let us now suppose a globe (fig. 2) in which the centre of gravity, B, does not coincide with the centre of symmetry, A. Draw a diameter through these points (A and B) and prolong it to C; the laws of gravitation will in this case make all the waters belonging to such a globe concentrate about the prolonged diameter on the side of the globe nearest to the centre of gravity, and, provided the surface be altogether smooth, they will form a perfectly circular sea, D, deepest in the centre, gradually shallowing towards its circumference; this again overlaid by all the atmosphere, E, assuming in its outline in like manner a perfectly circular form and also deepest in the centre; inequalities in the surface of the globe will of course modify these appearances, but a sufficient distance between the centres will occasion that side of the globe most distant from the centre of gravity to be as destitute of water or air is that portion of the moon's surface which has ever been exposed to the investigation of our telescopes. Unite two such globes as in fig. 3. In which A, representing the earth, has its seas distributed all over its surface, the whole having an enveloping atmosphere, and B, the moon, having its centre of gravity, x, more distant from the earth than its centre of symmetry, B, then its water and air would take the form represented in the figure; and the moon always keeping the same side towards the earth, it is quite evident that her sea and her atmosphere could never be seen by an inhabitant of the earth. It is thus clear that no mountain ridges are required to keep the Lunar Seas from flowing towards the side next our earth, nor in this case would any of the visible inequalities there ever be able to retain the smallest appreciable quantity of either air or water.

Fig. 1.

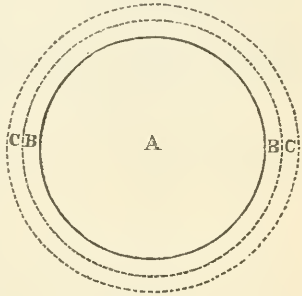
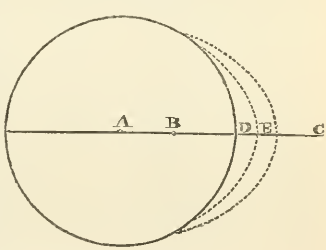


Fig. 2.



The effect of gravitation, as exerted by the earth on the waters of the moon, supposing it thus constituted, is by no means so readily understood; but strange as it may seem, it would only occasion such a tide in the Lunar Seas as would tend to increase their central depth; in other words, to heap up their waters in that part of the moon which lies most distant from the earth.

Even to the unassisted eye the surface of the moon showing different shades of colour, may suggest the idea of heights and hollows existing in that planet; the telescope proves the existence of mountain ranges generally of a circular form, and of large comparatively level plains, which at one time were supposed to be seas, and hence their names, "Mare Nubium," &c., &c. Modern observation proves that no waters roll in these seemingly arid wastes—in my opinion, the inquiry which here naturally suggests itself to the observer is not, what has become of the waters of these so-called seas? but, did waters ever exist in them? When examined by telescopes of great power, such as Lord Rosse's magnificent reflector, the mountain ranges seem almost without exception to be of volcanic origin; generally circular, with a central valley, having again in its centre a small conical hill, they resemble most wonderfully our terrestrial volcanos; even the lava currents and volcanic stratification are in some clearly traceable, while neither on their rugged sides, nor on the enormous blocks which in one or two instances are visibly strewed over the flat bottoms of the central valleys, does the abrading power of water appear ever to have exerted its strength, even although these central valleys are mostly sunk below the level of the general surface. At the same time it is but just to state that large regions are also to be found perfectly level, and seemingly possessing an alluvial character, and in one or two cases mountain ranges which afford no proof of volcanic structure have also been observed.

Fig. 3.

Another question naturally suggests itself. Allowing that at one time seas rolled and rivers ran on the face of the moon presented to our earth, and that by some as yet unknown influence these waters had been abstracted from their original abode and drawn down through the opened windows of heaven in such enormous quantities that "all the high hills that were under the whole heaven were covered." What has now become of these waters? Why do they not yet prevail? They do not seem to have been returned to the moon.

Before concluding this short and imperfect notice, it may be right to state that even our earth, having, as may be readily seen by inspecting one of the common terrestrial globes, one of its hemispheres mostly covered with water, while on the other, land is in large excess, would indicate a slight difference between the true place of its centre of gravity and centre of symmetry. I may also state that in the case of a globe of the size and constitution of our moon (being rather more than 2100 miles in diameter), a distance of about forty miles between these two points would occasion the phenomena above referred to. It might also be a subject of no small interest to inquire into the appearances which a world constituted as the moon is thus supposed to be, would present to its inhabitants; but this, with many other interesting, and therewith connected discussions, belonging more properly to Astronomy, cannot be here entered into.

I am, your obedient servant,

Reswallie, 15*th Oct.*, 1861. JAMES POWRIE.

CRADLEY PTERASPIDES.

Dear Sir,—On the part of Mr. Roberts I must be thankful, I suppose, for the concession extracted from Mr. E. R. Lankester, whose "*every*" has now diminished into "*most*," and whose "*most*," after another month's recollection, will probably shrink into "a vanishing quantity."

At the earliest opportunity I shall submit the fish in question to the examination of Sir P. M. De Grey Egerton ; meanwhile let it pass as *P. rostratus*. This note will therefore close the subject. With many thanks for the kindness and courtesy of the Editor,

Yours, &c.,

Mallæus.

HUMAN REMAINS IN THE VALLEY OF THE TRENT.

To the Editor of the Geologist.

Sir,—It was my intention to abstain from offering any opinion upon these "remains," until Dr. Bevor, of Newark, had recovered them and given me an opportunity for their inspection ; but the letter of J. H. W. in your last number induces me to offer a few remarks.

The first account of these remains came from a mutual friend of myself and Mr. F. Drake, residing in the Vale of Belvoir, and from some want of detail in the communication, it was supposed they were found in the "Vale,' but on a visit we found the true state of the matter, that they were found in an excavation made for the foundation of a bridge built by the Great Northern Railway at Muskham, a village about two miles from Newark. We visited the spot, and made notes from Mr. Chowler's very clear and detailed account of the excavation, with which he was familiar from its commencement to its termination, it being upon his farm. Most unfortunately, in geologizing recently at Aust Cliff, on the banks of the Severn, I lost my pocket-book containing these notes, but the details are yet so fresh in my mind that I can recal them without difficulty.

The excavation, although surrounded *on all sides* by a very pure gravel of an ochreous character, such as is common to the Trent valley, was not made in a gravel, but in a succession of soft, unctuous, alluvial deposits, sometimes sandy and pebbly, but all dark coloured, and so soft that a stick could be thrust into them with ease ; the beds were so distinct as to give the appearance of being deposited at different times ; at least, the impression produced was that the materials were not all poured in together. It was at the bottom of these beds, and before penetrating into the gravel beneath, that the remains were found : the conclusion I came to was, that originally there had been a deep hollow or pit, either natural or artificial, which had been filled up with river-silt by a *succession* of overflows of the Trent ; such depressions in the Trent valley are common enough. I saw one opened in continuing the Great Northern line to Nottingham ; it was filled with a soft, black, tenacious, peaty mud.

The character of the remains is somewhat against their being found in a "drift" gravel ; elephant remains are common enough in the "drift" of the Soar valley,* and they may easily have been brought into the Trent by floods washing them out of the banks of the Soar, flowing as it does for many miles through beds of this "drift gravel ;" and at the junction at Red Hill these would be poured into the Trent stream, and mingling with modern remains, would be swept into these hollows in the valley at the time of any great flood. This would account for the pottery, a

* *Geologist*, vol. ii. p. 174.

very puzzling affair, if we suppose these remains contemporaneous with the drift gravel and elephant remains.

I should suppose the drift gravel of the Trent valley was deposited when the waves of a tidal river (possibly reaching as far up as Burton-on-Trent) washed on the one side the Bunter Sandstone, on which stands Nottingham Castle, and on the other the steep slopes of "Clifton Grove," and the long ridge of Triassic hills terminating at Red Hill. depositing the gravels found so abundantly on their northern sides, but that certainly would be an age far, very far back in time, compared with the age of the deposits at Muskham.

Leicester, 15th Oct., 1861. JAMES PLANT.

FOREIGN CORRESPONDENCE.

Abstract from Professor Suess's Paper

ON THE LARGE CARNIVORA FOUND IN THE AUSTRIAN TERTIARIES.

(Imperial Academy of Sciences, Vienna, Proceedings, Vol. xliii. p. 217, Meeting, March 7, 1861.)

(TRANSLATED BY COUNT MARSCHALL.)

MANY years before Darwin's celebrated theory came to light, the question whether the repeated changes in animal and vegetable creation were the effects of changes in the external conditions of organic life, had been discussed among many palæontologists.

The solution of this question having to be sought for only within those deposits the Fauna of which is so nearly allied to that of present times that we can hope for a rather clearer idea of the condition in which these extinct forms were living, I have, a long time ago, been gathering a store of materials for the history of the Vienna Tertiaries, intending, in obedience to Bacon's precept—"Non disputando adversarium, sed opere naturam vincere."

I have now to treat this matter,—first, in its stratigraphical aspect, describing the changes in external physical circumstances, then as a question of palæontology, inquiring into the action of those changes on the organic being coeval with them. I have previously had occasion to publish some result of my investigations in both these directions (see Acad. Proc. 1860, vol. xxxix. p. 158-166); and among the most important of them I may number the separation of the Vienna tertiaries into an Alpine and Extra Alpine basin; the statement of repeated upheavings, of coevality of the apparently different deposits of Nussdorf, Grund, Baden, &c.; and lastly, the distinction of several successive Faunæ of terrestrial mammalia. Since that time the means liberally afforded to me by His Majesty's Lord-Chamberlain's Office,* have enabled me to visit during the summer of 1860 the whole western side of the Vienna basin, and to measure altitudes fit for being made a basis of a tabular synopsis of the bathymetrical distribution of our tertiary marine fauna. M. de Schwabenau having kindly informed me of the discovery of a Tertiary bone-bed at Baltavar (W. Hungary), the Imperial Geological Museum entrusted me with a mission to this place, where, by long-continued diggings, I succeeded in finding, in an horizon which I think answers to the gravel of Belvedere (Vienna), remains of species most characteristic of the well-known Fauna of Pikermi, in Attica,—such as *Machairodus cultridens, Hyæna Hipparionum, Dinotherium sp., Rhinoceros sp., Sus Erymanthius, Antilope brevicornis, Helladotherium Dunervoyi, Hippotherium gracile,* &c.

A rich collection of Pikermi fossils recently sent to the Imperial Museum by Baron Breuner-Felsach, then His Majesty's Ambassador at the Court of Athens, came in due time to confirm me in the conviction of the identity of my Second Mammalian Fauna of the Vienna basin (Inzersdorf, Belvedere) with those of Pikermi, Eppelsheim, and Mr. Lartet's "Miocène supérieur" (Cucuron, Vaucluse).†

Other remains of Mammalia, preserved either in public or in private collections, have convinced me that our Vienna marine deposits, including remains of *Mastodon angustidens, Mast. tapiroides, Anchitherium Aurelianense,* and *Listriodon splendens,* answer exactly to M. Lartet's "Miocène moyen," an horizon to which, as proved by the specimens in the collection of the Joanneum at Gratz, the coal-bearing tertiaries of Parschlug, Eibiswald, Wies, and Aflohtz (Styria) must likewise be referred.

The coal of Zemlye, near Totis (Hungary), including remains of *Anthracotherium magnum,* together with the deposits of Zouercado (Venetia), Cadibona (Piemont), and Rochette (Canton de Vaud), represents another and lower horizon, answering M. Lartet's "Miocène Inférieur," or the "Aquitanian strata" of the Helvetian Palæontologist, and the Fauna of which is anterior to the formation of the Vienna Basin in the strict sense of the term.

Before general results can be drawn from the comparison of terrestrial Mammalian Faunæ, the species of some of the most important families must be duly determined and limited, to obtain (at least partially) a basis such as has been obtained from the marine Fauna by the distinguished researches of MM. Hörnes, Reuss, d'Orbigny, &c.

For obvious reasons Carnivora are constantly very inferior in individual number to their herbivorous contemporaries; and consequently their fossil remains are comparatively scarce. Even in our country the individuals of *Ursus spelæus,* buried in one single cave under diluvian deposits, may in some cases be numbered by hundreds, and the remains of badgers are said to be equally frequent

* Vienna Imperial Museum of Natural History, Antiquities, &c., as well as the Imperial Gallery of Pictures, is under the control of His Majesty's Lord Chamberlain's Office, from whose funds they receive their allowances.

† Bulletin de la Soc. Géol. de France, 1859, Vol. xvi. p. 476.

in the caves of N. Bohemia. One single cave near Theissholz (W. Hungary) afforded remains of bears, wolves, foxes, martins, and hyænas — *Imp. Geol. Institute*, Jahrbuch, 1858, *Verhandlungen*, p. 147); another cave in Hungary contains a remarkable quantity of *Felis spelæa*. The real cause of these great numbers is, however, that these caves were once the retreats of these animals, where for a number of subsequent generations their remains were accumulated. Carnivora are notably scarcer in the diluvial Loam (Löss) of the plains; and what I myself saw in such localities is little better than some few fragments.

Besides some loose teeth from the marine littoral deposits of Nussdorf, near Vienna (referable, as M. H. von Meyer remarked many years ago, to four different species, one of them probably insectivorous, but insufficient for accurate determination), and an anterior half of a lower jaw from a Mammal (probably referable to the family *Canidæ*), out of the lignite of Eibiswald, kindly communicated to me by Professor Oichhorn, I know only three species of Tertiary Carnivora existing in Austria, and these are *Machairodus cultridens* (one individual), *Hyæna Hipparionum* (two individuals), and *Amphicyon intermedius* (one individual).

Machairodus cultridens.

The only remains of this large and powerful Carnivora known by me to have been found in Austria is an upper angular tooth from Baltavar, perfectly agreeing with the previously described specimens from Epplesheim and Pikermi. It may be, therefore, sufficient for me to notice a peculiarity left unmentioned by other descriptions. The ex-denticulated external edge is notably inclined towards the inner side of the tooth beneath the upper end of the crown, as indicated in Professor Owen's *British Foss. Mammalia*, p. 180, fig. 69, on the right. Isolated tubercles appearing first on the middle line of the opposed side, at last join upwards in forming a second denticulated edge; a slight trace of denticulation is likewise traceable near the middle line itself. The same particularities have been noticed by Professor A. Wagner in the teeth from Pikermi, preserved in the Museum of Munich. The localities of *Machairodus cultridens* hitherto known, are Eppelsheim, Pikermi, the Arno Valley, and Baltavar. The tooth found in this last-named place is in M. de Schwabenau's collection at Oedenburg (Hungary).

Hyæna Hipparionum, Gervais.

The remains of this species, the first representative of the genus *Hyæna* on our globe known to occur, have been discovered some in Austria, and two halves of lower jaws found at Baltavar; the one is in the Vienna Imperial Museum, the other in M. de Schwabenau's collection. Among the Pikermi fossils presented by Baron Breuner-

Felsach to the Imperial Museum is a left upper jaw, from a young individual just changing its teeth; a remarkable specimen, as almost proving the identity of *Hyæna Hipparionum*, Gerv., with *H. eximia*, Roth. and Wagn., and admitting a more accurate comparison of this species with *Hyæna spelæa* and their living congeners.

The individual first described by M. Gervais (*Zool. Pal. Franç*, p. 121, pl. xii., f. 1) differs from the Pikermi specimen only by being less in size; another individual (*loc. cit.* pl. xxiv., f. 2-5), described by him as being "equal in size to *Hyæna spelæa*, and *H. crocuta*," leaves no doubt as to the specific identity between the individuals of Pikermi and Cucuron (Dept. de Vaucluse); affording at the same time an argument for the diffusion of this species over the whole of Middle Europe.

The tubercular tooth of *H. Hipparionum* surpasses in size those of any other living or extinct congener; and the shape of the root suggesting the presence of an independent apophysis on the posterior portion (somewhat damaged in our specimen), the form of the fossil tooth stood next to the tubercular tooth of young individuals of the living *H. fusca*. There are still other analogies with the dentary system of young individuals of living species.

Amphicyon intermedius, H. v. Meyer.

The fresh-water limestone of Tuchoritz (Bohemia), first described by Professor Reuss (*Vienna Imp. Academy Proc.*, 1860, vol. xlii., p. 56), contains a certain number of Mammalian remains, among which, besides those of *Rhinoceros* or *Acerotherium*, of *Chærotherium Sansasniense*, Lart. (*Sus Chærotherium*, Blainv.), and *Palæomeryx Scheuchzeri*, H. v. M., mixed with some few impressions of leaves (*Diospyro-brachysepala*, A. Br., and *Leguminosites Proserpinæ* [?], Heer), Professor Suess has recognised eighteen loose teeth, entire or fragmentary, belonging to one and the same individual of a large carnivorous mammal.

The laniary tooth of the left lower jaw, quite different from the analogous teeth in the genera *Felis*, *Hyæna*, and *Ursus*, belongs evidently to an animal of the family *Canidæ*, evidently of more omnivorous habits than any other of this family, and larger in size than *Canis Neschersensis*, *Can. Issiodorensis*, or any other fossil species immediately referable to the genus *Amphicyon*, Blainv.

The laniary tooth of the upper left jaw, far inferior in size to the same tooth in the Wolf, and of a more omnivorous character, next resembling *Amphicyon minor*, Blainv. (Tab. xvi.)

The fragments of molar teeth, minute and incomplete as they are, prove the existence of at least three molar teeth (one more than in the genus *Canis*), of which the third or hindmost is provided only with one root. The incisive teeth resemble those of *Amphicyon* as figured by Blainville; one of them shows conspicuously the compressed and flattened shape characteristic of this genus. From all these circumstances, the following constitution of the dental system of the Carnivore whose remains are found in the fresh-water limestone of Tuchoritz may be inferred. Incisors very much flattened, without superior apophysis, the outer upper ones canine-like ; canines strong, moderately incurved, of oval transverse section, each with two strong vertical ridges ; Pre-laniaries very high, number unknown ; Laniaries, especially the upper ones, comparatively small, of evidently omnivorous character in both jaws ; Upper Molars more than two, the last one rooted ; of the Lower Molars the last or penultimate, with single root, is only known.

All these characters concur in denoting a genus of the *Canidæ* less carnivorous than the typical genus *Canis*, and even less so than any other form of the Tertiary genus *Amphicyon* as made known by Blainville. Notwithstanding certain analogies with *Otocyon*, the least carnivorous genus of living *Canidæ*, there is no reason for generically separating the form here in question from *Amphicyon*.

None of the species established either on Blainville's figures nor on generally rather incomplete remains found in Tertiary deposits being found to agree completely with the specimens from Tuchoritz, I thought proper to consult M. H. v. Meyer, who had previously described some species of *Amphicyon* from the Tertiaries of S. Germany. This distinguished Palæontologist answered me kindly in the following words : " The species whose teeth you were pleased to send to me in figures, I think to belong to my *Amphicyon intermedius*. The transversal tooth answers a complete specimen which I know to have come from the freshwater limestone of Kirchberg, near Ulm ; not quite complete specimens of upper and lower laniaries, and outer upper incisor from the Molasse of Ermingen and Heppbach, are only different from their somewhat larger size ; they answer still better to incomplete teeth, in fragments of upper and lower jaws of *Amphicyon intermedius*, found in the brown coal of Köpfnach (Switzerland), and probably also in the Molasse of Günzburg."

Remains of *Amphicyon*, so far as is known at present, have exclusively been found in deposits ranking among M. Lartêt's " Miocène moyen," and " Miocène supérieur," perhaps even only in the first of them. As far as I know, they have not yet been met with in the strictly so-called Vienna Basin.

MEETING OF SAVANS AT SPEYER.

By H. C. Sorby, F.R.S.

Having been present at the meeting of German naturalists (Versammlung deutscher Naturforscher und Aerzte) held at Speyer in the middle of last September, I thought that probably a short account of such papers as were more or less closely connected with geology might interest some of your readers. On the whole, the meeting is analogous to our British Association, the various branches of science being divided into nine different sections; but a larger number of miscellaneous subjects are brought before the general meetings. I confined myself entirely to the section for mineralogy and geology, at which, however, no very great number of papers were read.

In opening the proceedings, the president for the first day, Dr. Nöggerath, gave an account of M. Daubrée's experiments in connexion with the theory of volcanos, described in the May number of the "Geologist" for this year, p. 195, and expressed doubts as to whether with an indefinitely greater thickness of rock than that used in the experiments the tension of the steam would be indefinitely increased. M. Daubrée, on his arrival a day or two after, admitted to me that this doubt had already occurred to him, and said he intended to clear it up by experiment.

Professor Blum, whose investigations and writings on pseudomorphs are so well known, read a paper on the question whether certain examples are really due to alteration, or whether, as argued by M. Delesse, they are merely crystals of a foreign substance enclosed in an unaltered crystal. He exhibited a very excellent series of specimens, which I had previously carefully examined with him at Heidelberg, and they appeared to me to completely establish his own views with reference to those particular cases. After this the president said that the subject of pseudomorphs had been brought before the members of the section, but perhaps they did not know that a manufacturer of pseudomorphs was present amongst them, and called on me to exhibit and describe the specimens I had with me. I said that in my experiments I had endeavoured to accomplish my purpose rather by length of time than by a very high temperature. In some cases I had kept crystals of various minerals in the appropriate solutions for many months, at the ordinary temperature; and for other pseudomorphs had enclosed the crystals in tubes of glass or brass and kept them for some weeks or months in the boiler of a steam engine at a heat of about 145° C. (293° F.). In this manner I had succeeded in making a considerable number of pseudomorphs, similar to those met with in nature; the only striking difference being that often the manufactured specimens are of smaller grain, and have sharper angles. Amongst them are carbonate of lime in the form of gypsum, of fluor-spar, and of carbonate of baryta; carbonate of iron, and carbonate of zinc in the form of calcite, and of aragonite; carbonate of baryta in the form of the sulphate; and carbonate of iron, and the black oxide of iron in the form of gypsum, in which latter two instances there has been a complete replacement of the original constituents, but the crystalline form is perfectly preserved.

Dr. Kurz read a paper on the variegated sandstone of Germany, the chief point being whether certain beds which have been looked upon as deposited one over the other, were not really contemporaneous, but formed under different physical conditions. After which Dr. Mohr made some observations on the origin of limestone. He thinks shells and corals abstract their calcareous substance from the gypsum dissolved in the sea water, and that the carbonate of lime brought into the sea by rivers is altered to the sulphate by the sulphuretted compounds given off from decaying organic bodies. Dr. Redenbacher described in detail a new species of Pterodactyle from Solenhofen, and then Dr. Otto Buchner read a paper by Haidinger on his views respecting meteors, of which notice is made in the last number of the "Geologist"

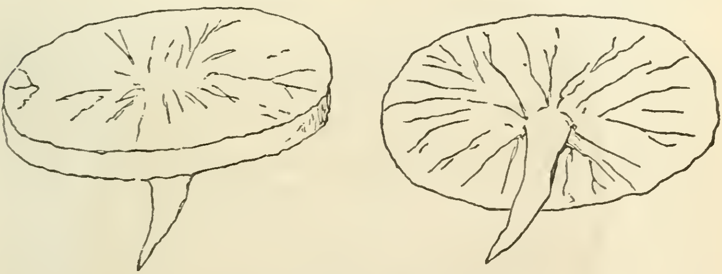
(p. 420). He exhibited the section of an interesting specimen which had a structure similar to that of the Septaria so well known to geologists, and through his kindness I am able to reproduce a print taken from it.

Dr. Buchner is now occupied with a monograph on meteors, and is anxious to figure all that are known. For this purpose he would feel extremely obliged if any one who possesses specimens would send drawings of them to him, to Giessen, with a statement of their weight. Drawings of those in the British Museum are already promised.

Professor Knop gave a very complete account of certain copper ores from Africa, describing the various decompositions and changes they have undergone, and confirming his conclusions by experiments. This led to a considerable discussion, in which it was argued that in some places the facts were the very opposite to what the author had stated, and it was concluded that in some instances reverse chemical decompositions had occurred, as, for instance, the change of carbonate of lead to the sulphuret, and of sulphuret to the carbonate.

M. Van Beneden described the numerous and excellent fossils now being found in excavating for the fortifications at Antwerp, including a number of vertebrata. The shells are, on the whole, like those in the basin of Bordeaux, and show that the strata are of Miocene age.

Mr. Grothian exhibited some fossils from the tertiaries and chalk near Brunswick. The most remarkable of these were some curious



Coeloptychium clerminum.—Römer.

Coeloptychium lobatum.—Goldfuss.

and interesting sponges, and through the kindness of the author I am able to give outline drawings of the most characteristic forms. One of the principal objects he had in view was to show that the different species described by Goldfuss and Römer are only varieties.

Professor Kjerulf, of Christiania, read a paper on the extension and origin of the iron ores of Norway, which he argued are due to eruption; and, as far as the manner of their occurrence is concerned, may be well compared with trap dikes. At the same time, by the term eruptive he did not necessarily mean that they were of mere igneous origin.

Dr. Blialoblotsky brought forward various objections to the theory of the purely igneous origin of granite. As is well known, and as has been pointed out by many authors, those difficulties are so great, that not a few geologists have gone into the opposite extreme, and almost entirely denied the instrumentality of an elevated temperature. Since I myself have argued against both these extreme views, and in favour of a theory which I look upon as a sort of happy medium, I am so far prejudiced as to admit the truth of some of the author's objections, but to think he carried his conclusions too far against the igneous theory.

Dr. Volger afterwards exhibited and described some pebbles, said to be sometimes water-worn, which occur in a brecciated vein. The spaces between the fragments and pebbles are filled with a crystalline deposit of quartz and felspar, and thus the deposition of those minerals from water (most likely at a high temperature) is rendered very probable.

Professor Blum read a paper on some peculiar agates. In one case there had been a horizontal deposit at the bottom of the cavity, and then the upper part had been at first coated over with a concentric layer of chalcedony, and finally filled with crystalline quartz. The chalcedony having been subsequently removed, the nucleus of quartz was left quite loose and unattached in the upper part of the cavity. This communication gave rise to a lengthened discussion, in which Dr. Volger said that in his opinion agates were not usually formed by the direct introduction of siliceous matter into empty cavities, but that there previously existed either a piece of limestone or a cavity that had been filled with calcareous spar, which had subsequently been replaced by agate. In this manner he would explain why in many cases the layers of agate are of such an uniform thickness both at the top and bottom, which he contends would not have been the case if they had been empty cavities filled directly. In support of his views he described some interesting veins in Saxony, which at a great depth are calc-spar, higher up a mixture of this with chalcedony, and at the top only the latter with pseudomorphs in the form of calcite, thus proving its replacement by chalcedony. After this, Professor Schönbein exhibited some fluor-spar, which when pulverized gave off ozone. Hitherto he had met with such specimens at only two localities, but suggested that mineralogists should examine those from others, so as to learn the circumstances under which this peculiar variety had been produced.

At the general meetings no paper of geological interest was read except that by Dr. Zöllner, on the nutrition of plants, in which he described some experiments made along with Liebig, showing that the inorganic constituents are not merely derived from the substances existing in a soluble form in the soil, which would soon be washed out by the action of the rain water, but that the rootlets have the power of dissolving substances insoluble in rain water by means of an acid excretion. They had found that the development of the rootlets is in inverse proportion to the richness of the soil, and thus by an increase in the sphere of their action the rootlets make up for the poverty of the soil.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Liverpool Geological Society.

October 8.—The Rev. Professor H. Griffiths, Vice-President, in the chair.

"Report of the Excursion made by the Society to Holywell, July 11th, 1861." By Henry Duckworth, F.G.S., F.L.S.

The mountain limestone of the neighbourhood contains many species of the ordinary fossils in profusion; *Productus giganteus*, *P. semireticulatus*, *Lithostrotion basaltiforme*, and *Syringopora geniculata* being the most common. The formation may be divided into the following subdivisions:—

1. Numerous beds of chert.
2. Shale and limestone with concretions of chert.
3. Black limestone.
4. White limestone.

The position of the cherts in No. 2 is similar to that of the flints in the Chalk formation, but their form is different, being round, flat concretions, thick in the centre, and gradually thinning towards the circumference.

"Report of the Excursion made by the Society to Coalbrookdale, July 31st, 1861." By George H. Morton, F.G.S.

The low land to the west of Coalbrookdale, towards Buildwas, is Wenlock shale; the lofty ridge, including Benthall Edge and Lincoln Hill, is Wenlock limestone, with Millstone-grit, and the Coal-measures reposing thereon. The following fossils were obtained on the occasion:—

Wenlock Limestone.

1. Heliolites Murchisonii.
2. „ megastoma.
3. Propora tubulata.
4. Favosites Forbesii.
5. „ cristata.
6. „ fibrosa.

Wenlock Limestone.

7. Lebecheia conferta.
8. Halysites catenularia.
9. Syringopora bifurcata.
10. „ fascicularis.
11. Thecia Swindernana.
12. Cyathophyllum articulatum.

Wenlock Limestone.

13. Omphyma Murchisonii.
14. Aveolites Grayii.
15. Cystiphyllum sp.
16. Calymena Blumenbachii.
17. Athyris tumida.
18. Rhynchonella spherica.
19. " nucula.
20. " borealis.
21. Atrypa marginalis.
22. " reticularis.
23. Strophomena depresssa.
24. Euompholus rugosus.
25. " discors.
26. " sculptus.

Wenlock Limestone.

27. Euompholus funatus.
28. " carinatus.

Wenlock Shale.

29. Encrinital stems.
30. Calymena tuberculosa.
31. Lingula.
32. Orthis hybrida.
33. " biloba.
34. " elegantula
35. Rhynchonella sp.
36. Leptena transversalis.
37. Acroculia?

Crustacea are rare at Coalbrookdale, when compared with the same formation at Dudley.

Abstract of paper "On the Inferior Oolite." By the Rev. S. H. Cooke, M.A. The Inferior Oolite, as developed on the Cotteswolds, near Cheltenham, consists of four chief divisions.

1. Ammonite Sands, about forty feet thick, transitional between Upper Lias and Inferior Oolite is the character of its organic remains, some being peculiar to it, as *Rhynchonella cynocephalus*, well seen at Frocester and Haresfield Hills.

2. Pea-grit, or Pisolite, forty feet thick, confined to the immediate neighbourhood of Cheltenham; pisolitic in structure, with many fossils, some peculiar to it.

3. Freestone and Oolitic Pearl series, about a hundred and ninety feet thick Leckhampton Hill; the freestone much quarried for building, but generally unfossiliferous; the Oolite-marl-bed, about seven feet thick, produces many fossils, which are very constant; near Stroud it contains a thin coral reef, with *Nerinææ*.

4. Ragstone, about thirty-eight feet thick; a hard gritty rock, with many fossils (*Gryphæa Buckmannii*, also found in the Swiss Jura and Swalica; and *Rhynchonella spinosa* are peculiar to this division). It keeps a nearly constant thickness over the whole district, while all the inferior divisions, along with the Upper Lias, thin out, and finally disappear towards the east and south-east. Thus at Stonesfield the ragstone is thirty feet; resting on Upper Lias six feet, and that on Marlstone twenty-five feet.

Inferior Oolite is also developed near Dundry, where the chief fossiliferous bed probably corresponds in place with the Cheltenham Pisolite; also in Dorsetshire, near Bridport, where it forms the coast section, but is much disturbed by faults. Its fauna in these more southern localities differs much from the Cotteswoldian, the Bristol coal-field having formed a complete barrier between them. It is also largely developed on the Yorkshire coast, about Scarborough, where it reaches the thickness of seven hundred feet, and produces thin beds of coal, with many ferns and plants. Here, too, its upper beds extend quite up to the Cornbrash, the Great Oolite and Forest Marble being absent.

Berwickshire and Tyneside Naturalists' Field Clubs.

On the 24th of August there was a joint meeting of the Berwickshire and Tyneside Naturalists' Club at Alnwick. The geological party went to Ratcheugh, under the able guidance of Mr. George Tate of Alnwick. The great basaltic whin sill at the Crag is divided into two distinct beds, between which are strata of limestone and shale. The great basaltic crag, on which the tower stands, is seventy or eighty feet in thickness, and slopes to the south-eastward; but towards the south end of the section it dwindles down to a few feet thick, proving that it is not a regular continuous stratum, but a wedge-shaped mass intruded among the mountain limestone beds; and, in accordance with this, the heated igneous basalt has changed the shale below into porcelaine jasper, and the limestone above into crystalline marble. From the top of the crag Mr. Tate pointed out the range of this basalt through the county, from Kyloe on the north, to Glenwhelt on the south; and especially showed that its relative position among the limestone strata is not the same throughout its range; in one part a well recognized limestone sill is immediately above it, and in others many fathoms below it.

Glasgow Geological Society.

The annual general meeting of this Society took place on October 3rd, when the following gentlemen were elected office-bearers of the Society for the ensuing year:—Dr. Scoules, M.D., F.L.S., President; Thomas Struthers and John Young, Esqrs., Vice-Presidents; James Horne, Esq., Honorary Secretary; Robert W. Skipsey, Esq., Treasurer.

Council of Management.—Messrs. H. W. Crosskey, Wm. Johnston, J. C. Douglas, Mark Fryar, F.G.S., James Stewart, Ed. Wimsch, Jas. Armstrong, Wm. Carey, James Thompson, Walter Graham, Andrew Armour, James Easton.

The following lectures are to be delivered during the winter session:—

October 31.—"On the advantages of Geological Studies, as recreative—as a mental discipline, and as promoting æsthetic culture." By Rev. William Frazer, of Paisley.

Nov. 7.—"On the Volcanic Rocks of the Scottish Carboniferous Formation, as illustrated by the extinct volcanos of Auvergne." By Archibald Geikie, Esq., F.G.S.

A course of Seven Lectures on Inorganic Geology. By John Scouler, Esq., M.D., F.L.S,, President.

Nov. 14.—General view of Geological Science—causes at present in action—changes of climaate. Nov. 21.—"Decay of Rocks from Chemical and Mechanical Causes, and consolidation of Strata." Nov. 28.—"Renovating causes—Volcanic Action." Dec. 6.—"Influence of the Organic Kingdoms in the formation of Strata." Dec. 13.—"Stratified Rocks and their Classification." Dec. 20.—"Igneous or Eruptive Rocks." Dec. 27.—"Metamorphic Rocks."

January 9, 1862.—"On Dislocations and other Disturbances in Coal and Metal Mines." By Mark Fryar, Esq., F.G.S., Glasgow School of Mines.

Jan. 16.—"On the Winning and Working of Coal." By Ralph Moore, Esq., Mining Engineer, Glasgow.

Jan. 23.—"On Chemical Analysis as an aid to Geological Inquiry." By Dr. Wallace, Mechanics' Institution.

Besides the above course, there will be the usual series of papers and dis cussions.

BRITISH ASSOCIATION MEETING.

THE BURNLEY COAL-FIELD.

By Joseph Whitaker, Member of the Manchester Geological Society, and T. T. Wilkinson, F.R.A.S., &c.

Although of limited area, the coal-field of Burnley is uncommonly rich, not only in its stores of fossil fuel, but also in points of stratigraphical interest, and in organic remains. It comprises within itself a complete series of the middle and lower coal-measures.

It may be described as occupying a basin like a valley surrounded by high ranges of hills, amongst the most prominent of which may be noticed Pendle on the north, Boulsworth on the east, Gorple towards the south, and Hambleton on the west, some of which rise to near two thousand feet above the level of the sea. Geographically it occupies the lowest portion of the valley, geologically it is the highest, when considered with reference to the stratification of the district.

The most productive portion of the field underlies the town of Burnley, where it assumes the form of a long trough, bounded on the east and west by two lines of upheaval, running nearly parallel.

The greatest depth to which the strata has been pierced occurs on the Fulledge estate, where a depth of six hundred feet has been attained, and where the following seams of coal have been found:—The Dog Hole Mine, or top bed, six feet thick; Kershaw Bed, three feet; Shell Bed, two and a-half feet; Burnley Old Five feet, or main coal, five feet; Higher Yard Bed, three feet; Lower Yard Bed, Low Bottom, or four feet coal; Thin Coal, two and three-quarters feet; Great Mine, or Bing Bed, four feet.

These are locally known as the Burnley "Top Beds." They include about thirty-five feet of coal embedded in about six hundred feet of intermediate strata. For a depth of about two hundred feet below these no coal occurs.

Then come the Arley series, or Habergham mines, consisting of the following workable seams:—The China Bed, two feet thick; the Dandy Bed, three feet; the Arley or Habergham Mine, four feet; giving a total of nine feet of coal to about four hundred and forty-five feet of interposing strata.

A series of strata devoid of coal of at least five-hundred feet in thickness here again form another natural division of the measures, which is succeeded by the Gannister series comprising a foot mine with a hard gannister floor; the Spa Clough Top Bed, two and a half feet thick; Spa Clough Bottom Bed, four feet; or a total of about eight feet of coal with six hundred and eighty feet of intervening strata.

From the lowest coal of the Gannister series to the Rough Rock, or the highest member of the Millstone-grit formation the distance is something over three hundred feet.

Hence, omitting many thin seams of less than a foot in thickness, there is, from the highest mine of the Burnley measures to the highest member of the Millstone-grit, an entire total of over fifty feet of coal for a depth of two thousand and twenty-five feet of strata. The millstone grit series of coals occur next in the descending order, consisting of three thin seams of less thickness than one foot, none of which have been worked in the neighbourhood of Burnley. After which the higher and lower members of the millstone-grit formation are developed in great thickness, passing down into the Yoredale Rocks, or limestone shale, and finally into the Carboniferous Limestone of Clitheroe. Of course, it is to be understood that the whole of the above enumerated series of strata have not been sunk through at any one place, neither can we point out any particular locality where they are exhibited in section; but the whole of them crop out between Burnley and the north end of Pendle Hill, and by taking advantage of the cloughs and ravines which present themselves on the way, nearly the whole of them may be noticed; or, if a pit were sunk from the centre of the coal-field in Burnley, to a sufficient depth, the entire series would be found to overlie each other in the above stated order.

In describing the rocks of the Burnley coal-field and their fossils, it will be found convenient to notice them in the ascending order, beginning with the limestone shale, or Yoredale rocks. They consist of very dark and finely-laminated shales, replete with fossils of marine origin, such as shells of the genera *Avicula pecten*, *Goniatites*, *Orthoceratites*, *Posodonia*, &c., &c.; they also contain fish remains of various genera, including that of *Palæoniscus*. The Yoredale series is well developed on the north-west, north, and north-east sides of Pendle Hill, skirting along its base from Pendleton Hall on the west to Burst Clough on the east, a deep ravine which takes its name from the pent-up waters of the morass on Pendle Hill having twice burst forth in great force during the seventeenth century, laying bare the rocks to a height of at least two thousand feet.

The higher and lower members of the Millstone-grit are the next rocks in the ascending series.

They consist for the most part of coarse-grained sandstones intermixed with water-worn quartz pebbles; being divided by thick beds of strong stony micaceous grey shale.

There are many good sections of these rocks exposed to view in the vicinity of Pendle Hill, where they are dipping nearly south at angles of from twenty to forty degrees, the intensity of dip increasing in a southerly direction.

The millstone-grit formation is poor in fossils, with the exception of a bed of shale of about twelve yards thick, which occupies a middle position between the higher and lower portions. The outcrop of these shales is exposed in the brook at Roughlee and at Hanson's Scar, near Sabden; at both of which places it contains fossils of the genera *Phragmoceras*, *Goniatites*, *Avicula pecten*, *Posidonia*, and *Orthoceratites*.

Near the top of the grit formation there occurs three thin seams of coal, known as the millstone-grit, or Brooksbottom series of coals, the outcrop of which may be seen in the road behind Height House.

The roof of the lowest of them, which consists of a fine-grained, compact, light-coloured sandstone, has been extensively quarried along the line of its basset on Read Height for road materials, and has been thought by some persons to be identical with the gannister, or mountain mine, but from which it differs in the following important particulars:—1st. It lies a considerable distance below, while the true gannister is known to be above the "Rough Rock." 2nd. The hard stone which is found in connection with it forms the roof of the coal and not the seat, as in the case of the gannister; and, 3rd. Possesses all the characteristics of a roof rock as distinguished from that of a seat rock.

The next ascending basset is that of the Rough Rock with the Boaredge and probably the Featheredge coals. A good section of this rock, together with the coals usually found in connection with it, is exposed at Height Side, near Padiham.

The outcrop of the Rough Rock is followed by that of the gannister, or the mountain mine series of coals.

The lowest of the gannister series, which is a four feet coal, identical with the Spa Clough bottom bed, is perhaps the most interesting, on account of its fossils, of any mine in the Burnley measures.

Its roof consists of a thin stratum of very fine black shale, of about four inches, in which there are embedded large numbers of very fine shells, in a high state of preservation, of the *Buccinum*, *Pyramis*, *Catillus*, *Bellerophon*, &c., together with the jaws, teeth, and scales of fishes. This thin stratum of shale is succeeded by another shale (the pecten), in which the conditions of life have been entirely changed; the *Bellerophons*, &c., which were so numerous in the preceding shale, have been entirely swept off, and their places supplied by immense numbers of *Pectens*, *Goniatites*, and *Orthoceratites*.

The pecten shale reaches a thickness of several feet, and is followed by a third shale, in which the conditions of life have been once more changed; the only representatives found in this shale of the immense number of shells that inhabited the waters by which the pecten shales were deposited, being a few very large *Goniatites*, which appear to have survived the changes that destroyed their predecessors.

In the last-mentioned, or third shale, there are embedded small ironstone nodules, in which are enclosed very small, but very elegantly marked, *Goniatites*, specifically distinct from those of the preceding shale; others of these balls, when broken, exhibit entire specimens of ganoid fish.

It is well known in some localities as the "Bullion Coal," in consequence of being interspersed with pyritous nodules, called by the miners "bullions," some of which contain *Sigillaria*, *Lepidodendra*, and other coal-measure plants, in a high state of preservation.

One hundred and forty feet above the bullion coal, there lies the middle coal of the Gannester series, or Spa Clough top bed, which is succeeded at a distance of twenty-one feet by the foot mine, with a hard gannister floor.

In the roof of the former of the above coals there have been found some very fine rays of the *Gyracanthus*, also teeth of *Rhizodus*, *Megalichthys*, and *Holoptychius*, together with scales, plates, jaws, bones, &c. Also, six hundred and seventy-five feet above the gannister, the Arley series of coals occurs, consisting of the Habergham, or Arley mine, four feet; the Dandy, three feet; and the China, two feet. From the bone-bed in the black shale roof of the lowest, or Arley mine, which is the most valuable of the Burnley mines, splendid specimens of fish remains of the genera *Megalichthys*, *Rhizodus*, *Diplodus*, &c., have been collected.

The distance from the Arley to the lowest mine of the Burnley higher series is about four hundred and sixty feet. It is a four feet coal divided into two seams by a bed of "Bing," in which, lying in heaps, are embedded coniferous fossil fruit of the genera *Trigonocarpum*. The roof of this coal contains a small species of *Anthracosia*, also some good *Lepidostrobi*, enclosed in ironstone nodules.

The next higher coal is about two and three-quarters feet thick, and identical with the Fulledge thin bed; it is exceedingly rich in ichthyological remains. The parting between the coal and roof has yielded very fine jaws, teeth, scales, and vertibral bones of the *Megalichthys Hibbertii*, also very perfect teeth of the *Ctenoptychius pectinatus*, *C. apicalis*, together with rays belonging to the *Gyracanthus*, *Hybodus*, *Pleuracanthus*, &c. The roof of this coal is a very finely laminated black shale, replete with the remains of fossil fish, some of which were examined during the Association Exhibition in the Free Trade Hall, Manchester, by Sir Philip De M. G. Egerton, M.P., F.R.S., F.G.S., &c., and the Earl of Enniskillen, D.C.L., F.R.S., &c., and have been declared by the above eminent ichthyologists to be entirely new to science. It also contains a very attenuated looking bivalve-shell.

About twenty-one feet above the thin mine there is a bed of impure cannel, over which there is a band of large *Anthracosia*. In the shales below the cannel two species of *Anthracosia*, much smaller than the overlying ones, are met with.

The next overlying coal is a four feet, having a roof of strong blue shale, containing an abundance of coal-measure plants, some of which have the *Spirorbis carbonarius* adhering to them. At a distance of seventy-five feet above the last-named coal, we have the Lower Yard Bed, the roof of which contains a band of very large *Anthracosia*, thought by some geologists to be identical with the *Anthrocosia robusta* found over the Arley mine in the Wigan district. The outcrop of this mine, together with the overlying band of *Anthrocosia*, is exposed near to the north entrance of the Towneley tunnel.

The next ascending coals are the Higher Yard Bed; the Main Coal, five feet; Shell Bed, three feet; and the Kershaw Bed, three feet; none of which have any fossils in connection with them worthy of special notice.

Nearly twenty-one feet above the Kershaw Bed, and about thirty feet from the surface, lies the Dog Holes coal, the highest and the thickest of the Burnley mines. The roof of this coal, consisting of a light grey sandstone parted by bands of blue shale, whenever laid open, has revealed in the greatest abundance ferns of the genera *Neuropteris*, *Pecopteris*, *Sphenopteris*, &c., together with both the stems and leaves of *Lepidodendron Sternbergii*, *Calamites*, and *Stigmaria ficoides*, perforating the rock in every direction; some of the latter having been traced for many yards in a horizontal position, sending out their rootlets at right angles to the main stems to a great distance. Large fossil trees of the genera *Sigillaria* are also abundant, some of them reaching a diameter of several feet. Seven such were found in the limited space occupied by a small cotton mill recently erected in Church-street, Burnley, by Mr. Dixon; and others were found in Mill-lane during the construction of a common sewer. The whole of them being in an upright position, thus afforded the best possible evidence that they had grown and flourished on the spot.

The whole of the overlying rock may be described as an immense fossil forest, occupying the central part of the Burnley coal-field; the town itself being situate on what was once one of its richest lagoon jungles, replete with the flora of a former geological period.

ON THE OCCURRENCE OF GOLD IN MERIONETSHIRE.

By T. A. Readwin, F.G.S.

The author confined his observations to an area of about twenty square miles, situate north of the turnpike road leading from Dolgelly to Barmouth, county Merioneth.

Professor Ramsey has ably described the geology of this district, in a communication to the Geological Society of London, 1854 ("On the Geology of the Gold-bearing Districts of Merionethshire.")

The Dolgelly district is bounded, or nearly so, by the picturesque and tidal river Mawddach, the great Llawllech or Merioneth anticlinal range, and the little river Camlan, to which may be added a continuation of about three miles further north-east, at the junction of the Cambrian sandstone, and the Lower Silurian Lingula flags of the Geological Survey, and included in the survey-maps 75 south-east and 59 north-east.

In this district are found the Cambrians overlaid by the Lower Silurian Lingulas. The Cambrian rocks are coarse greenish-grey grits. The Lingula-flags are arenaceous slaty-beds, interstratified with courses of sandstone. Calcareous and greenstone dykes frequently penetrate both the Cambrian and Silurian rocks. In the latter, the direction of the dykes is generally parallel with the lines of bedding; in the former, if any particular order obtains, their general direction is rather across the strike.

The metalliferous products are chiefly galena, copper pyrites, blende, manganese, and mundic, most of which are frequently found associated with native gold.

According to Sir Roderick Murchison, "The most useful position of gold is in quartzose veinstones, that traverse altered palæozoic slates, frequently near their junction with eruptive rocks, whether of igneous or of aqueous origin. The stratified rocks of the highest antiquity, such as the oldest gneiss, or quartz rocks, have *seldom* borne gold; but the sedimentary accumulations which followed, or the Silurian, Devonian, and Carboniferous (particularly the first of these three) have been the deposits, which, in the tracts where they have undergone a metamorphosis or change of structure, by the influence of igneous agency, or other causes, have been the chief sources whence gold has been derived."—*Siluria*.

Referring to the discoveries of gold in the Dolgelly district, Professor Ramsay says: "In the Ural Mountains, South Australia, Canada, and other parts of the world, gold occurs in rocks of the same general age, and apparently under the same circumstances."—("GEOLOGIST," Feb., 1858.)

Sir R. Murchison's statement is singularly corroborated by the position of the quartzose vein in the Clogau mine, distinguished as the "gold lode," which traverses altered palæozoic slates, near the junction of an eruptive bar of porphyritic greenstone, and the same law appears to obtain, also, with respect to all the gold-bearing quartzose veins of the Dolgelly district, upon the ores of which the author has made a very large number of experiments during the past eight years.

There are, in this district, about twenty localities in which gold has been discovered, visible, in quartz, or associated, more or less, with galena, blende, copper-pyrites, telluric mismuth, carbonate of lime, schist, baryta, iron-pyrites, &c.

By far the richest discoveries of gold have been made at the Dol-y-frwynog, Prince of Wales, Cambrian, and the Clogau Mines. Gold has also been found in the "Marine Drift," by the Hon. F. Walpole, Sir Augustus Webster, myself, and others; and Mr. Arthur Dean, in a paper read before the British Association in 1844, stated, "that a complete system of auriferous veins exists throughout the whole of the Snowdonian or Lower Silurian formations of North Wales."

Upon faith in this statement much current gold of the realm was expended at the Cwmheisian Mines, and very little bullion obtained by smelting operations, for reasons which are now not very difficult to understand.

About ten years later, gentlemen of my own acquaintance, after having set the most eminent assayers to work, to prove the accuracy of Mr. Dean's statement, expended nearly as much money upon the same spot, in the erection of machinery, which produced even less gold by amalgamation than the former method, although it was then held as an axiom that gold always exists in a *metallic* state, that mercury always has an affinity for gold, and, therefore, whenever gold is present in minerals, mercury will necessarily dissolve it. This did not, however, prove to be the case.

The result of operations upon some hundred and fifty tons came at length to be considered, at the best, an inigmatical failure, as the following extract from notes of the experiment will show.

Memorandum of one of thirty-seven large experiments at the Cwmheisian Mines, in 1854:—

Experiment No. 7.—A bulk of four and a-half tons of metalliferous minerals quartz, &c., was triturated in forty-two pounds of mercury. The result was *without* amalgam. The mercury was of the consistency of paste, ten pounds of which, on distillation, gave seventy grains of residual metal, which contained 18.4 grains of gold.

A qualitative analysis of this metal gave gold, silver, lead, mismuth, zinc, arsenic, and traces of copper and iron.

The distilled mercury contained traces only of zinc and arsenic.

Eight samples of ore were taken from the same heap as the above four and a-half tons, and qualitative analyses made. The results were, silica, lime, magnesia, alumina, oxide of iron, oxide of manganese, copper, zinc, sulphur, antimony, arsenic, gold, silver, and in three samples carbonic acid.

It had been proved before the experiment, and has since been proved, that there were several ounces of the "Royal Metal" in the bulk operated upon; but the quicksilver, in that instance, as in many others, became sportive, neglected royalty, and took up with "associates" of less dignity, although, intrinsically, of more real utility.

This, however, was anything but the result expected.

At the Dol-y-frwynog Mine, about two years afterwards, Sir Charles Price erected machinery, at a great cost, for the extraction of gold by amalgamation. Several hundreds of tons were operated upon; but the machinery itself being only a bad imitation of that used at the Cwmheisian Mines, the result was a failure equally provoking.

Of all the gold localities of this district, at the present time, the mine in the Clogau Mountain is the most interesting, as it is the most profitable. The Clogau Mine, as it is called, is situate at an elevation of one thousand feet above the level of the sea. The "Saint David's," or "Gold Lode," is the most remarkable feature of this mine.

The direction of this lode is nearly east and west, and is almost perpendicular. It is about three feet wide, and is composed of quartz impregnated with sulphides of copper, lead, iron, and occasionally telluric mismuth, with much native gold, which is generally distributed in minute particles throughout the quartz, but very frequently in rich strings or bunches. A shallow adit has been driven on this lode about twenty fathoms, and a winze sunk to within a few fathoms of a deeper adit, which has been driven from the north about forty-eight fathoms, and touches the gold lode a few fathoms further east than the forebreast of the shallow adit.

This lode is at the junction of the Cambrian sandstones and the Lingula-flags of the Lower Silurian rocks, and was worked many years since, and a large quantity of what was then called "poor copper-ore" raised and sold. More of it was requested by the Flintshire smelters at an advance of five shillings per ton!

It is a singular fact that, in 1854, the grass-grown refuse of this "poor copper-ore" was examined, and large stones were found showing positively the presence of native gold in extraordinary quantity. Many of the stones weighed several pounds, and had gold disseminated throughout. The author was once told by an eminent gentleman in London, who ought to have known better, that getting the gold into the stones was "an ingenius contrivance betwixt a jeweller and a watchmaker."

One specimen of this "refuse" in particular, containing a large quantity of gold associated with telluric-mismuth, has the mark of a boring-iron, which has passed quite through the solid gold.

Some of this "refuse ore" was put to the test by Mr. J. C. Goodman, and, in one instance a hundred pounds weight yielded fourteen and a-half ounces of gold.

This remarkable load has been experimented upon, for limited periods, and in various ways, by several persons since the gold discovery of 1854, and many strings or shoots of gold obtained equally rich; but, owing to the uncertain operations of amalgamating machines on the one hand, and the mines themselves being the subject of *two* chancery suits on the other, the general value of the lode in bulk has not, until recently, been determined.

The author has for a long time been of opinion that it is impossible to arrive at an approximate value of auriferous minerals in bulk by the ordinary process of assay. Assays are likely to prove delusive, simply on account of the unequal distribution of the precious metal in the minerals. Many men of great abilities state the contrary; but they cannot do it for all that; for, if they cannot obtain a *fair sample* to assay, it is impossible that the assay to the bulk can be proportional.

In proof of this the author referred to a record of thirteen experiments made by himself just a year since, upon a hundred and twelve pounds of auriferous quartz from the Clogau Mine, part of a stone weighing about four hundred weight, which was broken from the lode on Whit Monday, 1860, sent to London, and crushed and sampled by Johnson and Son.

			Oz.	Dwt.	Gr.			Oz.	Dwt.	Gr.
Exp. No. 1.	7lbs.	of ore, gave	1	10	0	of amalgam, and	fine gold	0	8	10
,, 2.	7lbs.	,,	2	0	10	,,	,,	0	11	10
,, 3.	14lbs.	,,	3	14	12	,,	,,	1	3	0
,, 4.	7lbs.	,,	1	16	11	,,	,,	0	10	12
,, 5. ,, 6.	7lbs. } 7lbs. }	,,	3	6	2	,,	,,	1	4	5
,, 7.	7lbs.	,,	1	13	4	,,	,,	0	10	12
,, 8.	7lbs.	,,	2	0	12	,,	,,	0	10	10
,, 9.	14lbs.	,,	3	3	14	,,	,,	1	2	12
,, 10.	7lbs:	,,	1	10	10	,,	,,	0	11	4
,, 11.	7lbs.	,,	1	4	0	,,	,,	0	9	11
,, 12.	14lbs.	,,	2	16	4	,,	,,	0	17	5
,, 13.	7lbs.	,,	1	0	14	,,	,,	0	7	0
	112lbs.	,,	25	16	7	,,	,,	8	5	19

These experiments were very carefully made, because a gentleman in London, of very high standing in such matters, had declared the value of the ore by assay to be nine pounds only per hundred weight, whilst the author had ventured to declare it worth thirty pounds. He happened to be right, because trials of seven pounds weight are likely to be nearer the mark than those of only four hundred grains.

Lastly, he stated briefly the result of *actual working* operations for gold at the Clogau Mine, since the beginning of the present year.

Tons.	Cwts.		Ounces.	Dwts.
191	11	of good quartz, gave of gold	241	14
12	17	of better ,, ,, ,,	96	0
3	0	of best ,, ,, ,,	976	6
207	8	from the bulk of the lode, gave	1314	0

To this, if we add fifty-six ounces, the result of experiments in 1860 upon five tons, we have a total quantity of one thousand three hundred and seventy ounces of gold from two hundred and twelve tons of auriferous mineral, being at the rate of about six and a-half ounces to the ton!

The author believes this to be the first public record of a *hundred weight* of gold having been obtained from the Crown Lands of this country, the value of which is about five thousand three hundred pounds.

This "Royal Mine" pays a royalty of one-twelfth to the Crown. The cost of gold-extraction has been very inconsiderable, and there is a probability of a continuance of a yield of gold at the present rate for some time to come.

Seven years ago, the author determined, unwisely, perhaps, never to leave this vexed question until he had mastered it. He has done so. Experiments are ended. It is proved, what many then doubted, and many more derided, that gold does really exist in the Dolgelly district, and that it can be extracted from the minerals in remunerative quantity. He was glad to have had the opportunity of making this statement before the Geological Section of the British Association for the Advancement of Science.

At the conclusion of the paper, Mr. J. Beete Jukes, F.R.S , F.G.S., Director of the Geological Survey of Ireland, said the existence of gold in North Wales had long been known, but it was not in sufficient quantities to render its production remunerative.

A discussion ensued between Professor Smith, of Sydney, Australia, and Mr. Readwin, upon the modes of extracting gold from its matrix; Mr. Readwin stating that, at the Clogau mine, particularly referred to in his paper, the gold was extracted, at present, chiefly by a process of amalgamation.

Professor Smith inquired whether some of the mercury was not lost in the process? To which Mr. Readwin replied that some of the mercury was always lost; it became so finely divided that some of it was sure to be carried away.

Mr. Smith said he perceived that in old North Wales they were falling into the same difficulty as their friends in New South Wales. There were many things which would have a singular action upon mercury, and likely to injure its effect on the gold. The action they had was a chemical one, and therefore the gold producers of New South Wales had depended to a great extent upon mechanical action exclusively, and generally they had been very successful. If anyone could point out any means by which gold could be satisfactorily separated from the quartz it would be a great boon. The mechanical means they employed in New South Wales would leave only half an ounce per ton, which was considered very fair. The production of gold in Old North Wales, as detailed by Mr. Readwin, surprised him very much. The yield of gold in Victoria or New South Wales did not exceed one ounce per ton of quartz, and in many instances half an ounce was considered a fair yield. The digger of Australia would be extremely proud to get it in such quantities as six ounces per ton, as Mr. Readwin had stated the yield of the Dolgelly quartz to be. From three to four ounces per ton would be considered very good anywhere in the gold districts of Australia. In some small localities the yield had been as high as thirty ounces, forty ounces, or even more, per ton, but they were exceptional, and did not last long.

Mr. Readwin remarked that there was this difference: in the one case the gold was obtained; in the other, not. There was no difficulty about it. By the process of amalgamation care should, of course, be taken not to intrude any mineral that would have the effect of neutralizing the affinity of mercury for gold. In reply to the last observation of Professor Smith, Mr. Readwin said he believed that the same law of produce obtained with respect to gold as with other metals. In the case referred to it certainly appeared to be so.

In answer to another question, Mr. Readwin stated that the actual cost of obtaining the one thousand three hundred ounces of gold was, he should think, not more than three hundred pounds.

Lest there should be any misunderstanding as to the average yield of gold in the Dolgelley district, he begged distinctly to state that the average yield would not, in his opinion, exceed half an ounce to the ton of ore; but there were several extraordinary exceptions to the rule in some of the quartz-lodes of the district.

A gentleman asked what was the cost per ton of crushing the quartz?

Mr. Readwin said that as the machinery was worked by water-power, the actual cost of crushing per ton would, probably, be less than half-a-crown.

Professor Smith expressed his surprise, as the cost per ton in Australia was calculated on an average at one pound per ton. He referred to the fact that most of the firms there used the Cornish stampers for crushing the quartz, and that it answered the purpose well.

Mr. Readwin said that he also had witnessed the operation of gold extraction by means of stamp heads, and it was found to fail, in consequence of the finely-divided state in which the gold occurred; so fine, indeed, that it floated away on the surface of the water and was lost; the heavier portions were, of course, retained.

Mr. Readwin exhibited some extraordinary specimens of Welsh gold, and offered to explain to any person interested, a process by which minerals antagonistic to the free amalgamation of mercury and gold, can be successfully treated.

List of the Gold Localities of the Dolgelly District.

At Cwmheisian Uchaf, gold has been found in galena, mundic, copper-pyrites, quartz, blende, schist, and arsenical iron-pyrites.

Cwmheisian Issa, in galena and blende.

Dol-y-frwynog, in galena, quartz, baryte, and mundic.

North Dol-y-frwynog, extracted from quartz, copper-pyrites, and gossan.

West Dol-y-frwynog, in quartz, schist, and baryte.

Tyddyngwladis, in argentiferous galena, copper-pyrites, clay-slate, talcose-schist, gossan, and blende.

Caegwernog, in galena.

Berthllwydd, in argentiferous galena and arsenical iron-pyrites.

Prince of Wales Mine, in blende, galena, quartz, and clay-slate; but principally associated with blende.

West Prince of Wales, extracted from quartz.

The Cambrian Mine, in blende, carbonate of lime, schist, quartz, clay-slate, iron-pyrites; but chiefly in blende and quartz.

Victoria Mine, extracted from quartz and gossan.

Lachfraith, extracted from quartz and iron-pyrites.

Wellington Mine, in quartz and copper-pyrites.

Caegwain, extracted from quartz and galena.

Vigra, extracted from gossan, quartz, and copper-pyrites.

Clogau (South Grant), extracted from gossan, blende, quartz, and copper-pyrites.

Clogau (Middle Grant), traces of gold in copper-pyrites.

Clogau (North Grant), from "Saint David's Lode," in quartz, copper-pyrites, carbonate of lime, talcose-schist, galena, and associated with telluric-bismuth.

NOTES AND QUERIES.

Flint Implements at Aylesford, Kent.—Sir,—A few weeks since, a friend of mine picked out of some river drift which had been dredged from the Medway near to Aylesford, a most highly-finished flint hatchet. I am sorry to say I fear we shall lose it for our museum, as the finder is going to take it to Oxford. I have not had the luck to get a specimen, but hope to do so, as that elevated bed of ancient river-drift at the back of Aylesford church ought to yield some.—Yours, &c., W. H. Bensted, Maidstone.

Euomphalus carinatus.—Dear Sir,—Last month the Liverpool Geological Society made an excursion to the Silurian district of Coalbrookdale, during which many interesting fossils were obtained. From a quarry of Wenlock limestone on Benthall Edge, I obtained a finely-preserved specimen of *Enomphalus carinatus*, retaining a considerable portion of the shell. My reason for calling attention to this fact is that I cannot ascertain that this shell has been discovered in the Wenlock series before. Both in "Siluria" and Professor Morris's "Catalogue of British Fossils," it is mentioned as occurring in the Aymestry Limestone. Perhaps, if you consider these remarks worthy of insertion in the "Notes and Queries," some one of your numerous readers will inform me whether this shell has hitherto been met with in the Wenlock Limestone.—Yours, &c., W. S. Horton, Liverpool.

Native Coke in Moravia.—Native cokes have been found at Mährisch-Ostraw (Moravia), at a depth of about two hundred and eighty feet, along the line where one of the coal-beds worked there is in contact with eruptive rocks. The metamorphic action has penetrated into the coal to a depth of three or four inches. A similar occurrence was observed in 1856 in the coal-beds of Witkowitz, partially altered into cokes by the contact of greenstone.

REVIEWS.

"*Proceedings of the Geologists' Association*," *No. 7.*

The seventh number of these Proceedings has reached us, and it is with pleasure we remark, not only an improvement in the diction and printing, which would indicate that the matter has received some editorial care, and has been passed under some competent eye, but there is an improvement also in the quality of the papers themselves. In the first paper our old friend Mr. Wetherell, who for so many years has done so much good work in looking over little things, treats "On the Opercula of Ammonites in Flint Pebbles from the Gravel of Whetstone." In all strata containing ammonites the trigonellites should naturally be expected to be met with—as indeed they are—for to suppose them rare is a mistake, as any one may prove by cracking off sideways pieces from the mouth-edges of common grey-chalk ammonites, such as *Am. varians*, *Am. Mantellii*, and *Am. navicularis*. What is most wanted to be done is some one to spend his time in breaking up different species of ammonites and figuring the kind of trigonellites which belong to each. Another of Mr. Wetherell's papers printed is "On Oviform Bodies from the London Clay, Chalk, and Greensand," in which he draws attention to certain minute objects often found in the cavities of the tubes of fossil Teredines, but the origin of which is still unexplained.

Mr. George E. Roberts has contributed a "Notice of the Plant-bed cut into by the Severn Valley Branch of the West Midland Railway," the specimens met with being chiefly carboniferous ferns of the genera Pecopteris, Neuropteris, and Sphenopteris. Of the last a new species "with very small but most elegant pinnules," resembling a delicate form of Hymenophyllum, from New Zealand, was abundant.

The *Woodwardites Robertsii*, Morris, was first met with in these shales.

A long paper by Mr. Gray "On the Geology of the Isle of Portland," is illustrated by one of those pieces of hacked wood far too common in modern geological books. Of the short comings of the paper itself we are disposed to speak lightly, for the sake of the spirit in which it is penned, but there is one part to which we hope the author will devote more accurate attention. After speaking of the bone-fissures in the Portland stone, he adds:—

"Graves are frequently met with on various parts of the island, and from the discovery of vases, coins, and other articles in them, are acknowledged to be of Roman origin. These graves are generally sunk down into the calcareous slate of the Purbeck beds, and the body was deposited within a case, rudely formed of unhewn stones or slates—without the intervention of a coffin—the earth being filled in upon a covering of similar material.

"It would appear that the human remains are only found in fissures *beneath the calcareous slate*, so that it is highly probable that the weight of the earth, in the above instances, caused the heretofore undisturbed layer of slate between the graves and open fissures to give way, and launch its contents into the space below. Captain Manning, Her Majesty's Lieutenant of Portland, and resident magistrate, has in his cabinet at Portland Castle, a good collection of fissure-bones, *skulls, and other human remains*, as well as the bones of the deer, boar, and other animals, found in fissures in the central quarries, and therefore *below* the calcareous slate. In a cabinet, in the office of the Commanding Royal Engineer, Vern Fort, there are also several specimens of bones, the latter having been found on the Vern Hill, where the calcareous slate is not developed. These bones *were not accompanied by human remains*. The fissure-bones of Portland are generally found in good preservation, usually separate, but often cemented together by carbonate of lime, the shells of land snails being rarely associated with them. In some of the fissures, passed through by the Vern Ditch excavation, there were discovered numbers of shells, very delicate, yet well preserved, and similar to those described as common in the Loess of the Valley of the Rhine, viz., *Helix plebium*, *Helix nemoralis*, and *Cyclostoma elegans*. Numbers of them were detached, but they were principally cemented together with broken pieces of stone, and cherty fragments, into a concretionary mass, by a filtration of carbonate of lime crystallized, and encrusting each. The specimens obtained were thirty feet from the surface."

We confess we do not clearly comprehend what the author means. If he intends to say that the human bones are older than calcareous slate, we decidedly think he is wrong. On the other hand, we do not see the value of whether a fissure extends down through other strata to the calcareous shale or whether it does not.

The subject of human remains has a high interest just now, and Mr. Gray should give us the exact particulars of these bone-fissures and their contents.

Mr. Curtis contributes a note "On the Gault of Alice Holt Forest," and Mr. Pickering, Mr. Lionel Woodward, and other gentlemen have contributed other papers on different subjects, the series concluding with an illustrated one on geological hammers, in which some queer specimens of stone-breaking implements are duly figured, but not one of which is properly fastened in its handle—if the woodcuts before us are to be trusted.

The Committee announce their intention of having excursions next year to Cambridge, Hastings, Harwich, and Lewes. We approve highly of this early notice of these trips, as it is very desirable for the members of such a society as this to read up and study beforehand the features and fauna of the districts and strata they visit in their instructive excursions. The resumption of the Society's meetings will take place on the 4th inst.

The Coal-Fields of Great Britain. By EDWARD HALL, F.G.S.

It is not many months since we read and reviewed a very admirable account of our coal-fields, by Mr. Hull. The oft-mooted question, "How long will our coal-fields last?" and the commercial aspects of the probable increased exportation of coal, through the late treaty with France, turned attention pointedly to the subject, and with the maps, sections, and labours, published and unpublished, of the Geological Survey, extending over two-thirds of the coal districts of England, and assured of the cordial assistance of his colleagues, no one could undertake the reply with a better collection of materials, or so good a chance of success. And a very truthful answer Mr. Hull did produce, and the public appreciation of it is proved by the enlarged second edition before us. It is not to be expected that the answer first given should have been perfect, and, consequently, we find slight modifications; but to the main features the author consistently adheres, while in the intervening time fresh materials have been gathered. Amongst the additions is an account of the mineral resources of Scotland, which has been included with those of England and Wales; and sections of the coal series of South Wales and Somersetshire. The production of the various coal-fields has been modified in accordance with the "Mineral Statistics" for 1859, collected by Mr. Hunt, and a map showing the area of the productive coal-fields, and the probable depth and extent of the coal formation below the newer strata, is now furnished, besides an additional horizontal section of the formations in Lancashire. Chapters on the "Duration of our Coal Supply," and on "The Physical Geography of the Carboniferous Period of Britain," are also added, and in justice to Mr. Hull, it may be fairly spoken, that he has produced what others have thought about and talked about, but never accomplished—a complete handbook of the British coal-fields.

In his preface, Mr. Hull alludes to the criticism of Mr. Vivian, in his "Lecture on Coal," and the statements of that gentleman on the resources of the South Wales coal-fields; but at present he makes no attempt at reply, giving this rather witty reason for procrastination, that as Mr. Vivian places the duration of the coal-field at 5000 years, and himself at nearly 2000 years, there will be abundance of time for arriving at an amicable conclusion on the subject, before the course of events shall have verified or falsified either of their calculations.

In the appendix, are some interesting notes on coal-mining in foreign countries, amongst others, in China and Japan. In respect to the former, mention is first made of the statements of Marco Polo, the traveller of the thirteenth century, that coal was in use in his day in that country. At the present time, the coal is "worked in the cliffs of the Pe-Kiang river, at Tingtih, by means of adits driven into the side of the hill, at the outcrop of the coal-seams. The works are carried on in the most primitive manner, without the aid of machinery, and the mode of working coal through vertical shafts, which may be considered as the second stage in the art of mining, appears little known. In this respect, as in almost every other, the Chinese are far behind their neighbours the Japanese. Probably, if an inhabitant of the Celestial empire were shown some of the largest collieries of Newcastle or Wigan, he would scarcely deign to look at them, or would gravely inform you that they had similar or better machinery, and deeper mines, in "Pekin side."

Mr. Oliphant, in his narrative of Lord Elgin's mission, states that coal is procured from a mine about five miles distant from the important city of "Whang-sheh-Kang," or "Yellow Stone," on the river Yang-tse-Kiang, about four hundred miles from its mouth. He also states that coal is raised in Japan somewhat extensively, but as a government monopoly. "One mine, at a place called Wakamoto, in the interior of the main island of Niphon, was visited by some of the Dutch mission. They describe the mine as being well and judiciously worked, and the coal as bituminous in its nature, and made into coke for use. That the coal is worked by means of vertical shafts, appears from the fact that the Prince of Fizen once ordered a steam-engine from Europe for pumping the water out of his mines; but, through the native jealousy of the presence of foreigners in the country, refused to allow the Dutch engineer to erect the machinery upon the spot. The Japanese, however, are quite independent of European aid for such an object, as they thoroughly understand the construction and management of the steam-engine. Kæmpfer, in his 'History of Japan,' also refers to the abundance of this mineral, stating that it is dug in great quantity in the province of Tseknsen, and in most of the northern provinces. The rich and productive empire also yields abundance of gold, silver, copper, and iron, and the Japanese armourers excel the Europeans, and perhaps any other nation, in tempering steel."

Short and brief as are these references, and introduced more even as matters of curiosity than anything else, and brief as is the chapter on the Coal-fields of the World, we are still glad that there is even this little mark of attention shown to the subject of foreign coal-fields, for hereafter will it not be only the question of how long *our* coal-fields will last, but we shall have to consider, as our coal-mines get *deeper*, how far foreign countries can compete with us in setting *their* cost of *carriage* against *our* cost of *uplift* and deep-mine draining; whether they will bring their coal-produce to our market, or carry it to other markets where material and machinery can be worked together.

We must not, however, consider that we have anything like a perfect knowledge of the stores of fossil fuel laid up in the crust of the earth. The constant finding of coals and lignites, usable as fuel, of other ages than the carboniferous, leads us to conceive the idea that future discoveries of most valuable beds may from time to time be made in deposits of various ages, although none of these are likely to equal the veritable coal-seams of the carboniferous age.

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SOME OBSERVATIONS ON THE ACCUMULATION OF CAVE-DEPOSITS.

By the Rev. Henry Eley, M.A., F.G.S.

The usual mode of accounting for the bone-breccias so commonly found in caverns open to the day can scarcely be considered by any body as quite satisfactory. It seems usually taken for granted that that mixture of sand, clay, small stones, and fragments of bone must necessarily have been brought there by streams of water, or washed in by waves. And yet in many instances—perhaps in by far the great majority of instances—nothing can be imagined as much less likely to have happened than the aggregation of such materials by any means of that kind: that it should have been an occurrence of almost universal prevalence may well be deemed impossible. For under what circumstance can it be conceived that floods of water, in every region where open caverns exist in the rocks, should have picked up a heterogeneous collection of bones just in time to lay them quietly down again in every hole into which the muddy stream could gain access? For we must really suppose so well-timed an acquisition of future fossils, before we can admit the usually received hypothesis of the manner in which they were deposited where we find them; since no one can suppose that the whole of the solid matter borne along by any great flood—not to say by every such flood—could have been such as we observe so constantly in these bone-breccias.

The utter insufficiency of this way of solving the difficulties which these collections present may be seen in the account given by M. Alfred Fontan of two bone-caverns in the Montagne du Ker, at Massat, in the Department of Ariège, as extracted from the November number (68) of the Quarterly Journal of the Geological Society of London, page 468.

After noting that there are many of these hollows or grottos in the mountain, he says: "Amongst these caves, two are remarkable on account of their extent. One of them, situated near the summit of the mount, at an elevation of about a hundred metres (three hundred and thirty feet) above the bed of the valley, is approached by a spacious vestibule, or outer chamber, with two large and lofty circular entrances, one of which faces the north, the other north-north-west. The soil of the outer chamber, which, like the rest, was devoid of all stalagmitic concretions, was smooth and horizontal, rising above the sill of the entrance. With the exception of a small portion near the north-north-west entrance, where a few fragments of pottery were found, mixed with cinders and coal, it presented the appearance of an abandoned river-bed. A sandy loam, sprinkled with gravel or small rolled pebbles, occupied the centre; whilst at the edges, against the wall of rock, larger but similarly rolled pebbles appeared to have been thrown up by the eddying or movement of the water. These deposits continued in the same way for a distance of a hundred metres along the principal gallery, only diminishing in thickness as they extended further inwards, and entirely ceasing at the further end.

"This arrangement, combined with the presence at such a considerable elevation of rolled pebbles, most of which were different from the rocks of which the mountain consists, appeared to the author as solely attributable to those diluvial cataclysms which geology points to as having occurred at several periods anterior to historical tradition. In order to understand these facts, he determined to study the nature of the deposits; for which purpose he caused a deep trench to be dug in the soil near the northern opening, and extended it to the lateral walls. The result of this first attempt was the discovery of a large quantity of bones of carnivora, ruminantia, and rodentia, amongst which were most abundant the great cave-bear described by Cuvier, a large species of hyæna (H. spelæa), and a large Felis (tiger or lion), all mixed together, rubbed and broken, giving evidence of a distant transport, or at least of a violent displacement. Besides the cinders and charcoal at the surface (with which were associated fragments of pottery, an iron poignard, and two Roman coins), another bed of cinders and charcoal was found at a depth of more than three feet in the ossiferous loam, and here M. Fontan found a bone arrow-head and two human teeth; the latter were at a distance of five or six metres one from the other.

"The second or lower cavern is situated at the foot of the mountain, close to the road, at an approximating height of twenty metres above the bed of the river. Its only opening, which, like those of the upper cavern, is contrary to the present direction of the water, leads into a tolerably spacious chamber, the ground of which consists of a blackish earth and of large rolled pebbles (some of them granite), amongst which are scattered, in the greatest confusion, fragments of bones belonging to animals either of extinct species, or of such as have for the most part long since ceased to inhabit these regions. They belong principally to deer (Cervus elaphus), antelopes, and aurochs; and there were a few remains of feline carnivora (apparently a lynx). Amongst these were found worked flints and numerous utensils of bone (deer's bone chiefly), such as bodkins and arrows; the latter were the most numerous, and are carved with oblique grooves, probably for poison. Some of the bones bear marks of incisions made by sharp instruments in flaying or cutting up the carcasses.

"In each cavern a chasm crosses the gallery and terminates the deposits; in the upper cave at a hundred metres, in the lower one at about seven metres from the entrance."

After a sentence or two of argument, M. Fontan observes: "From all these phenomena, the most striking feature in my opinion is this, namely, that the Valley of Masset appears to have been at one, and perhaps at several periods, the theatre of a vast inundation coming from the north-north-west or west, in the opposite direction to that of the present course of the waters of this region."

Now who can accept this as a satisfactory hypothesis of the formation of these deposits? It seems a needless labour to examine it in detail: it is incredible, upon the face of it, that the bone-breccias of these and numberless other caverns similarly circumstanced could have been accumulated in any such way.

But I feel very confident of being able to offer an hypothesis which will meet all the ordinary facts of these cases, and against which on insuperable objections can be alleged.

It so happened that, some years ago, I lived in company with a spaniel dog, I may almost say during every hour of its life, and in its daily habits I saw, unless I am much mistaken, an explanation of the origin of the bone-breccias. Though a very small creature, it was an indomitable hunter; no weather stopped it; to range the fields, the woods, and the ditches surrounding them was its one passion. Wet, dirty, and tired it came in at dinner-time, and having eaten its meal, it lay down to sleep. Upon awaking it began the operation which was surely enacted by the carnivora of the caves, and to which, as it seems to me, must be referred the curious mixture which now occupies their floors. With its teeth it pulled the mud from its long hair, and one would hardly have believed, had he not seen it, the heap of sand, clay, and pebbles which so small a dog left upon its rug. Had it been allowed to gnaw bones in the study—a delight which was forbidden—the ordinary materials of the breccias would have been complete—quite complete; for it deposited more than one or two of its own teeth, and abundance of its own hair, upon the floor.

Nothing could better consist with the hypothesis thus proposed than the facts observed by M. Fontan. Of his two caves, one was from two hundred and fifty to three hundred feet nearer to the level of the valley than the other. There accordingly were found the larger pebbles. How certain it is that the larger prey would be taken to this more readily accessible den, and would bring in larger masses of mud, with larger stones fixed in them; and not unfrequently in the hoofs of the large dead animals—the aurochs, for instance—and in the feet of the carnivora themselves; while in the cavern higher up on the hill, smaller portions, such as could be carried in the mouth without dragging, would more generally be disposed of, and with these smaller pebbles would be added to the accumulation.

Occasionally, I believe, there is an appearance of stratification in these deposits. But this by no means contradicts the hypothesis here offered. It might very well happen that a cave of this sort would be frequented by different genera of beasts of prey in succession—the cave-bear, hyæna, and tiger—each of which might occupy it exclusively for a lengthened period, and bring in different kinds of soil, as it sought its prey in the marshes, the meadows, the woods, or on the mountain-side. And, in M. Fontan's account, there seems to be proof that something of this kind had happened, for he found loamy sand in the upper cave, and a blackish earth in the lower,—a distribution of material very well agreeing with the view here taken, but not quite consisting with the notion of deposit by water; as sand and loam are usually heavier substances than black earth, and would rather than the latter have been left on the lower level.

I think, then, that the deposits of the open caverns may be ascribed for the most part to the carnivora frequenting them, which must have brought in, adhering to their own feet and fur, and to those of their prey, a prodigious quantity of earth and stones, which we must needs believe would remain where they left it, mixed with the fragments of the bones they gnawed, unless we are prepared to say that the floods washed all that out first to make way for a similar deposit brought from somewhere else.

CORRESPONDENCE.

CREATION BY LAW.

Sir,—I make no excuse for offering to the intelligent readers of the "Geologist"—a periodical in which the freest discussion has been invited and carried on respecting the "Origin of Species"—the remarks which a careful perusal of the latest published works on the subject have led me to express. I allude chiefly to Professor Owen's "Palæontology," a second edition of which has recently been given to an admiring world, and to the excellent little work by Mr. David Page, which you noticed in the "Geologist" for September.

In both these works there is a strong appeal made in favour of a "constantly operating secondary law," by which the several species of animals have been called into being. Prof. Owen's generalizations are as follows:—

"Palæontology has yielded most important facts to the highest range of knowledge to which the human intellect aspires. It teaches that the globe allotted to man has revolved in its orbit through a period of time so vast, that the mind, in the endeavour to realize it, is strained by an effort like that by which it strives to conceive the space dividing the solar system from the most distant nebulæ.

"Palæontology has shown that, from the inconceivably remote period of the deposition of the Cambrian rocks, the earth has been vivified by the sun's light and heat, has been fertilized by refreshing showers, and washed by tidal waves; that the ocean not only moved in orderly oscillations regulated, as now, by sun and moon, but was rippled and agitated by winds and storms; that the atmosphere, besides these movements, was healthily influenced by clouds and vapours, rising, condensing, and falling in ceaseless circulation. With such conditions of life, palæontology demonstrates that life has been enjoyed during the same countless thousands of years; and that with life, from the beginning, there has been death. The earliest testimony of the living thing, whether coral, crustacean, or shell, in the oldest fossiliferous rock, is at the same time proof that it died. At no period does it appear that the gift of life has been monopolized by contemporary individuals through a stagnant sameness of untold time, but it has been handed down from generation to generation, and successively enjoyed by the countless thousands that constitute the species. Palæontology further teaches, that not only the individual, but the species perishes; that as death is balanced by generation, so extinction has been concomitant with the creative power which has produced a succession of species; and furthermore, that, in this succession, there has been 'an advance and progress in the main.' Thus we learn that the creative force has not deserted the earth during any of the epochs of geological time that have succeeded to the first manifestation of such force; and that, in respect to no one class of animals, has the operation of creative force been limited to one geological epoch; and perhaps the most important and significant result of palæontological research has been the establishment of the axiom of the continuous operation of the ordained becoming of the species of living things." ("Palæontology," 2nd edition, p. 2.)

In a diagram illustrating the above generalizations, the genetic succession of animal life is summed up. It appears from this corrected statement of the latest discoveries in palæontology, that the class of fishes makes its first appearance in the Upper Silurian strata, and Prof. Owen draws the conclusion that "those species which are most useful to man have immediately preceded him in the order of creation," and that they "have superseded species which, to judge by the bony garpikes (*Lepidosteus*) were much less fitted to afford mankind a sapid and wholesome food."

The earliest known reptile is found, not, as generally supposed, in the Devonian age, but in the Coal measures, and all the earliest created forms belong to the lowest or Ganocephalous group, analogous to the *Lepidosirens*, or mud-fishes, which attracted so much attention at the Crystal Palace some time ago. It is not until the Tertiary times that the reptiles approach in organization to those of the present day.

The class birds is represented by footprints in the Upper Trias, in which stratum, however, no evidence has yet been found of actual bones, which more conclusive proof is not found below the Lower Chalk. All the earliest created birds exhibit the characters of the order *Cursores*, "characters of the embryo or immature individuals of the "higher orders of birds, and are consequently placed at the lowest step of the scale of ornithic organization.

In the higher class mammalia it is most interesting to find again that the greatest part of the earliest created mammalia belong to the lowest orders of the class. We find marsupials in the Upper Trias (*Microlestes*), and in the Oolitic beds. We find a solitary small vegetable feeding pachyderm *Stereognathus* in the Oolite, and a doubtful cetacean in the Greensand. But it is not till the Eocene division of tertiary time that we find the class reach its culminant development. The earliest created mammals were the nearest to the ideal archetype. The fossil *Anoplotheres* and *Palæotheres* resembled each other in their dentition more than the existing musk-deer and tapirs. The former extinct animals, however, gave place in the Miocene to true ruminants, and to mammalia more closely resembling the existing fauna. It is not until the Pliocene period that we find mammalia of the same species as the present. Some of the extinct forms, as the rhinoceros, elk, and hæyna of Europe, lived down to the period when man existed with, and probably extirpated them. At Abbeville, in France, and Köstritz, in Saxony, the remains of man are found in the same strata as the remains of those animals which are now confined to more tropical regions. The antiquity of the human race, as proved by the discoveries of M. Boucher de Perthes, is thus thrown back to a historically distant period, though a recent one geologically. As Prof. Owen says, "There seems to have been a time when life was not; there may therefore be a period when it will cease to be" (p. 412).

Professor Owen, after recapitulating the order in which animal life made its appearance upon earth, devotes much space to the subject of the extinction of species, and points out many species of animals which are vanishing before the onward march of civilized man. The dodo has disappeared from the Mascarene Islands within the last two hundred years. The beaver, once common in Wales in the historical period, survives still in the back woods of America, and is rapidly becoming extinct. The chase in Europe has almost extirpated the races of bears, wild boars, wolves, elks, and wild oxen, which peopled our English plains within historic times. The aurochs, descendant of the once formidable *Bison priscus*, is only preserved in Lithuania through the careful protection of the Emperor of Russia. The author of the present paper has been personally assured by an intelligent Moor, Hadj Arábi Ben-Is, that the breed of lions is rapidly verging towards extinction on the slopes of the greater and lesser Atlas. The elephants and rhinoceroses of Abbeville were contemporary with man, and most probably were extirpated by him. In the last century a colossal cetacean existed in enormous shoals in Behring's Straits, but has since succumbed to the ravages of the whalers. On the other hand, many species of domestic animals, as, *e. g.*, the horse, ox, sheep, &c., have been introduced by man into geographical situations remote from their original habitat.

With respect to the momentous subject of the "mysterious coming into being" of species, which has been canvassed amongst scientific men for the last hundred years, it is my object to endeavour to lay the present state of the question clearly before your readers.

The position in which the contending forces of special creationists and progressionists rest at present has little changed from those occupied by the great chiefs and antagonists of past science, Cuvier and Geoffroy St. Hilaire amongst palæontologists, Lyell and Sedgwick amongst geologists. The same creeds and watchwords are maintained by the hierarchs and generals of the day. But they are professed and given by different disciples, and by less obedient and even more mutinous sentinels. It is impossible for the most "prepossessed uniformitarian" to contend that there is not springing up at the present day a vast section of geologists who agree with Baden Powell in his memorable declaration that "while those arguments most commonly relied upon against transmutation are completely refuted, there is still no positive evidence to establish it as a demonstrated theory. Yet, as a mere philosophical conjecture, the idea of transmutation of species, under adequate changes of condition, and in incalculably long periods of time, seems supported by fair analogy and probability." Whether obscured by the dazzling sophisms of over-zealous teleologists, or mutilated in the corrupt elementary treatises of the day, the great morphological principles of *unity of, and adherence to, archetype, and successional development* throughout geological time, proclaimed by Owen, St. Hilaire, and De Blainville, seem fairly to have maintained their claim to be treated as legitimate postulates. The successive and special creations, "invented by Cuvier as Ovid invented metamorphoses," are no longer universally regarded as the way by which the enormous phenomena of living beings have been produced. The belief is rapidly increasing amongst biologists that the true appreciation of the causes which have originated such changes is to be arrived at by a careful examination of the phenomena exhibited by the lower animals, *e. g.*, *parthenogenesis*, and the alternation of generations. To form a just conception of the whole animal kingdom, such whole should be regarded in its most simple aspect, and it is not by a pertinacious negation of all theories, and by "an ossification of the organs of intelligence," that science will be advanced. While, on the other hand, any proofs which transmutationists may adduce should alone rest upon a studious regard of the phenomena of embryology, and upon a synthetic mode of treating nature.

The fact is now more clearly understood that "the types of animals first developed are more like the embryonic forms of their respective groups, and the progression observed is from those general types to forms more highly specialized." (Owen.) Thus the embryo ruminants *Anoplotherium* and *Dichodon* of the Eocene period appeared before the present stags and antelopes, and, in common with nearly all the Eocene mammalia, maintained their typical dentition of forty-four teeth, which has since given place to the more specialized and modified dentition of the forms of the present day. The lowest organized mammalia appeared first on our planet. At least four-fifths of the Secondary mammalia belong to the lower sub-classes *Lyen-* and *Lissen-cephala*, bearing close analogy, and perhaps affinity to the oviparous vertebrata. "In all the orders of ancient animals, there is an ascending gradation of character from first to last." Professor Owen has proved that "there are traces in the old deposits of the earth of an organic progression among the successive forms of life." "Man, the last created, whose organization is regarded as the highest, departs most from the vertebrate archetype." We must regard it as an event depending upon some higher law than that of mere empirical coincidence, that the most typical animals should be found first in the scale, and the most specialized last. These remarkable coincidences, coupled with the astonishing facts revealed to us by the labours of those naturalists who have by their researches on the changes and metamorphoses of the lower animals, discovered the great law of *Parthenogenesis*, by which successive alternate generations of animals are produced by and from some animals in no way resembling them, such produced animals, or their descendants, in turn reverting back to the original form (*e. g.*, the tape-worm), seem to "impress upon the minds of the most exact reasoners in biology a conviction of a constantly operating secondary creational law." (Palæontology, p. 407.)

I have the greatest doubt myself whether "natural selection" is this *vera causa*—this secondary law which has produced species. At the British Association last September, Prof. Babington said:—

"Nothing could be more disastrous for science than the giving up the study of individual forms. If the Darwinian theory led to the abandonment of our present idea of a species, it ought to lead us to be much more exact in the study of individual forms."

Dr. Lankester, at the same meeting, expressed his belief that:—

"Those who had supported Mr. Darwin had done so rather on the ground that his hypothesis had been a method of eliciting, arranging, and classifying a certain set of facts, than as believing that those facts led to the necessary acceptance of the hypothesis. There had never been an accepted theory of the origin of species; Mr. Darwin's strongest opponent could not pretend the contrary. Persons were getting too much to mis-estimate the value of forms. They did not recollect that every departure had been produced by some physical law—by some force operating upon that particular form; and that it was necessary to study what had been the external circumstances producing that change, whether the distinct origin of species was believed in or not. A great naturalist, who was still a friend of Mr. Darwin, once said to him (Dr. Lankester), 'The mistake is, that Darwin has dealt with origin. Why did he not put his facts before us, and let them rest?' He believed that that was where the public were in error—in supposing that those facts explained the origin of species."

Whilst condemning the universal application of the selective principle as an active agent capable of producing the complicated fauna of geological ages, let me express my admiration for those convincing passages in which Mr. Darwin offers a solution of the curious fact of the presence of wingless birds, *e. g.*, the *Apteryx* of New Zealand, the Dodo of Mauritius, the *Nesiotis* of Tristo da Cunha, in islands remote from the great continents. Natural Selection here may modify a bird's wings, where no functional requirement for their development exists, but it can never, in my humble opinion, produce an Ornithorhynchus or a whale from any bird or Cetiosaurian.

My readers will have read the chapters in which Mr. Darwin lays stress upon the enormous lapse of time required for the deposition of the geological strata. However they, like Professors Phillips and Thomson, may impugn the exact details of his statistics, they rise from the perusal of these chapters with the full conviction that the time required must have been immense. They can only comprehend such arithmetical amount by a comparison with those results which astronomical or mathematical science has arrived at, as to the vast distance between our globe and the solar or sidereal systems. In this extensive field they must reflect that the small portion of space in time which falls under their immediate cognizance and observation is not sufficient to enable them to pronounce with any certainty as to the vast laws which may govern the whole. An anonymous writer on the subject, by a direct illustration of the well-known phenomena* of Babbage's calculating machine, lays great stress upon this argument, and I confess I am inclined to regard it as an approach to truth. By some originally conceived law, consonant with the development of the original type, species which invariably propagate descendants immediately resembling themselves through countless ages, may, after the expiration of some given limit of time, or under the influence of some unknown condition, suddenly change their power, and develope organs which are superadded to the distinctive characters of their original type. I can see no other way of accounting for the existence of such exceedingly aberrant forms as the *Pterodactylus* or the *Ornithorhynchus*. Our induction is not sufficiently vast to lay down general rules upon the subject; but I think that if the old principle of "successive" and "special" creations representing the so-called "theological" epoch of thought, be abrogated, the principle of the uniformity of progression by natural selection, representing the equally baneful "metaphysical" stage, cannot erect itself a temple on the ruins of the former. It is only by a regard of the question of the origin of species, as one under the influence of some dynamical law, that a solution of this great problem can be arrived at. (Comte. Philosophie Positive.)

In the words of the eminent writer in the "Edinburgh Review": "Circumstances are conceivable—changes of surrounding influences, the operation of some intermittant law at long intervals, like that of the calculating machine quoted by the author of 'Vestiges,' under which the *monad* might go on splitting up into *monad*, the *gregarina* might go on breeding *gregarinæ*, the *cercaria cercariæ*, &c., and thus four or five not merely different specific, but different generic and ordinal forms, zoologically viewed, might all diverge from an antecedent quite distinct form."

Mr. David Page, in his recently published little work on the "World's Life-System," exhibited the spirit in which the advanced palæontologists of the present day have accepted the principle of Creation by Law, while they wisely abstain from defining its method, or fixing the precise process by which new species are originated.

I am glad to see that Professor Owen has elsewhere condemned any imaginary scheme by which some anthropoid ape, *e. g.*, the Gorilla, might, by Mr. Darwin's principle of Natural Selection, become a man. He is too well aware that the species is yet unknown to naturalists which is sufficiently allied to mankind to have served as its immediate ancestor. No person can seriously think that mankind, with its peculiarly developed brain, could have been recruited either from *Gorillæ* or *Dryopitheci*.† Those naturalists who assert man's simian origin,

* The statement made in the "Vestiges" with respect to the periodical difference in the results of the calculating process of Babbage's machine is founded on a mistake.—Ed. Geol.

† I am most anxious to avoid introducing anatomical subjects, which would be foreign to the pages of the Geologist, but I may take this opportunity of stating my belief based upon constant and careful observation, that the human brain possesses organs—e. g., the "third cerebral lobe," the "posterior cornu," and the "hippocampus minor," which are absent in the brains of the apes. I am aware that several zoologists have lately expressed a contrary opinion, but I cannot refrain from stating the result of my inquiries, although contrary to the theory of transmutation. Truth should be paramount over any preconceived hypothesis.

whilst pledging themselves to the as yet unproved empiric method of Natural Selection, retard the "rapid and right progress" of zoology, unmindful of the Baconian warning that "knowledge, whilst it lies in aphorisms and observations, remains in a growing state; but when once fashioned into methods, though it may be farther polished, illustrated, and fitted for use, it no longer increases in bulk and substance."

The study of the palæontological and biological sciences has revolutionized modern knowledge. The attention to system and detail, which *savans* of a past generation so carefully bestowed upon animals and plants, is now producing its good fruits, and the confused mass of facts and observations which have been collected is now giving place to wide and comprehensive generalizations. The mind of modern scientific men has been "slowly and insensibly withdrawn from imaginary pictures of catastrophes and chaotic confusion, such as had haunted the imagination of the early cosmogonists. Numerous proofs have been discovered of the tranquil deposition of sedimentary matter, and the slow and successive development of organic life." He who has studied the subject with care, quits it with the consciousness that he has learnt the important lesson that, however specialized and modified man's structure, he still retains within him the remnants of the old primæval *ἰδέαι*, the old patterns, exemplars, and archetypes of being, in whose perfect image he was originally designed; however remote in point of time he may be from the earliest incarnation of life on this globe, he still bears traces in his early career of a close analogy to the lowest organized monad; and, above all, he, from the simple elements of the originally created spinal chord in the lower vertebrata, has developed a complex organ of thought far surpassing that possessed by any other animal form.

I am, Sir, your obedient servant,

CHARLES CARTER BLAKE

GLACIERS IN WALES.

By PROFESSOR A. C. RAMSAY, F.R.S., F.G.S.

In the year 1851 I read a paper before the Geological Society "On the Superficial Accumulations and Surface-markings in North Wales," in which I attempted to show that there had been two glacier epochs in that country, one before, and the other after the deposition of the boulder drift, which was ploughed out of some of the larger valleys by the secondhand smaller set of glaciers; and in a later work on the old glaciers of North Wales, I went further, showing that cold sufficient to form glaciers lasted during the whole time of submergence and emergence, both when the higher mountain-tops stood out of the sea as a cluster of small islands, and afterwards when the whole land rose out of the water.

The first of these memoirs touched on several subjects not immediately connected with the glaciation of Wales, though bearing in a larger sense on the same Geological period, and on the same set of questions. This the Council of the Geological Society decided not to print in their Journal, on the ground that it was too speculative—an opinion with which, in a great measure I now coincide. One question was, however, raised in this unprinted matter which I do not yet remember to have seen in any published paper, and I now mention it because of late the attention of many persons have been more and more drawn to the discussion of the subject.

The opinion I then held was that cold great enough to have produced the first and larger set of glaciers in our own neighbouring counties might have arisen from an elevation of land equal to, or greater than, the amount of depression that it underwent during the middle portion of the glacial period. I then stated "that I hold it as a sound doctrine in Geology that any amount of depression that any part of the earth's crust may have undergone, may have been equalled there or elsewhere by an opposite movement, giving an equivalent amount of deviation. Bearing this in mind, it seems within the limit of fair speculation to suppose a possible upheaval, equal to, or exceeding the above-mentioned known amount of depression (2,300 feet*)—an elevation probably sufficient to have produced a degree of cold, taken in connection with other conditions, equal to the production of glaciers on the first and greater scale. This land (Wales) would then consist of a lofty central cluster of mountains, with numerous valleys, down which the larger glaciers flowed, debouching upon an elevated plateau of land, part of which now forms Anglesea and the sea-boards of Carnaervonshire. A further extension of this flat, dotted by other clusters of mountains, now forming the high grounds of Britain and Ireland, would spread as far as the 100 fathom line indicated by Sir Henry De La Beche in his 'Theoretical Researches,' including the German Ocean, the the Irish Sea, and a wide tract of the Atlantic stretching northward along the coast of Norway."

In 1846 the late Professor E. Forbes published his celebrated memoir "On the Distribution of the Fauna and Flora of the British Islands," in which, in consequence of a partial ideality in the littoral fauna of the North of Europe and of North America, he inferred a former direct union of these continents across the area now occupied by the North Atlantic. Generalizing on this idea, I conceived it probable that this northern continent might have stretched so far south "that the mean annual Isothermal line, and the January Isothermal line, that in Central Asia and in North America run nearly east and west in latitudes about 55 degs. and 38 degs., would be continued in the same direction across the continent instead of curving northwards, as they now do, under the influence of the Gulf Stream. The mean annual Isothermal line of 32 degs. Fahr. would then pass across the south of Scotland, and the January line near the south of Spain. Across the Altai Mountains, in Central Asia, at points between these lines in latitudes 49 degs. to 51 degs. north, the snow-line is 7,034 feet above the sea, and in those mountains (from 9,000 to 10,000 feet high) at the Colonne de Katoune, there

* Mentioned in a previous part of the Memoir, and printed in the Society's Journal.

are glaciers in latitude 50 degs. north. The Snowdon group is at least three degrees further north than this, and, if instead of being part of an island, that district, at a higher elevation, were part of a broad continent spreading east and west, we should have in its peaks and valleys all the conditions needful for the formation of large glaciers; and the same may be said of other mountain regions of the British Islands."

I now send you these speculations for what they are worth, although in the long run I think it will appear that the wide-spreading, long-continued, and most intense cold of the glacial period was due to some unexplained cause far more general than any mere changes in physical geography.

BRITISH ASSOCIATION MEETING.

ON A NEW POINT IN THE STRUCTURE OF SIGILLARIA, WITH SOME REMARKS ON THE BIVALVES OF THE COAL.

By J. W. Salter, Esq., F.G.S.

Among the very fine collections of fossil-plants in the Manchester Museum, are some specimens of *Sigillaria* well worthy attention, and which show, as I believe, a new point of structure, bearing on their aquatic habits.

They belong to that section of the genus which is distinguished by the leaf-scars, being arranged close together in the vertical rows, not at a distance apart, as in most of the species. So close, indeed, that they press on one another, and compel each other to take an hexagonal form.

At certain points along the trunk, new lines of scars are interpolated, so as to make the number of ridges greater (and at the same time the individual ridges narrower) in the younger portions of the tree. In *Favularia* these intercalations very much at particular spots, forming a sort of varix, or node, not very obscurely marked. At these points, too, *in certain* species, the stem is swelled, the spaces between the ridges deepened—the ridges themselves narrower and more prominent, and altogether angular in form. Brongniart's artist has badly represented such a varicose swelling in his figure of *Sigillaria hexagona*.

The species in which I have observed this characteristic are:—the *Favularia tessellata*, from Tonge, Bolton; *F. nodosa*, from Oldham, and a species from Glamorganshire; *F. hexagona*, from Manchester coal-field.

In a perfectly preserved stem of *F. tessellata*, from the roof of the "four-foot" coal, the intervals between the ridges are occupied by rows of circular scars, not hexagonal, nor purse-shaped, as the leaf-scars between them are, but round. Nor with the characteristic flattened surface and double imprint from which the vascular bundles of the leaf arise, but deeply indented, and with a minute protuberance in the centre, which structure is characteriscic of the rootlets of the underground portion of the stem (*Stigmaria*).

The look of these small interpolated scars is so different from those of th leaf-rows (they are clearly not interpolated ridges, for they die out at each end), and their position is so much what they would have if the swelled portion *had* emitted rootlets, that I think they must be points in the stem from which roots have been given off, such as we see constantly in water plants and marsh plants.

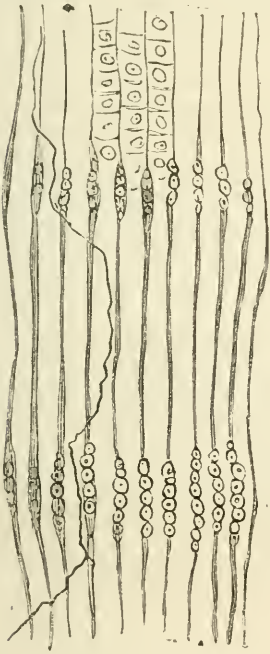
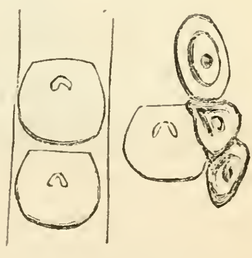


Fig. 1.—Reduced rough sketch of Sigillaria (Favularia tessellata), showing the position of the root-scars.



Fig, 2.—A few of the leaf-scars (a) and rootlet-scars (b) of the natural size.

Such roots from the nodes or varices of the plants are indeed common enough in all rooting stems; but there is no reason to believe these stems were sunk in the *earth* up to this point. All the appearance of the plant is against this. In a specimen of *F. tessellata* from Poynton Colliery, the nodes occur at distances of a foot apart, while the specimen is only six inches wide. The freshness and sharpness of the scars below these points, too, sufficiently negatives this idea; for in the underground portions of Sigillaria the leaf-scars are much obliterated, and the rows irregular, even before we reach the true Stigmaria scars on the large bifurcating roots.

But if the *Sigillaria* grew in water, as there is the strongest reason to believe they did—and the author referred here to Mr. Binney's observations and the conclusions of Prof. Rogers—it is likely enough certain of the species should have this rooting habit. And the structure I look upon as one more scrap of evidence (in addition to the extremely fine nature of the sediment in which they grew, and the sea-shells, and annelides, and worm-tracks intermixed with them) of the watery habitat of the coal-plants.

I am not now arguing for the water being salt; I think that can be well inferred from other data—perhaps chiefly from the nature of the animals of the coal-measures. I will only say that there are in the neighbourhood of Manchester instances of thick beds of coal, overlaid *immediately* by uniform fine shale (without a particle of grit or sand which might indicate a subsidence of the surface), which shales contain only marine shells. The majority of the shells, however, of the middle and upper coal-measures are not so decisive of their habitat, and I wish now to call attention to some of these.

Fig. .

The so-called "*Unio*" bands of the coal-measures are so well known as not to need description. In the condition of broad banks often several feet thick, they occur throughout all our fields: and though rare in the lower measures, they are not absent from them. A number of species have been described, some of them probably the merest varieties of the three or four well-marked forms originally described by Sowerby in the "Mineral Conchology." But others are distinct forms, and some yet remain to be distinguished and added to our lists. Some species appear to be characteristic of particular seams or bands in the coal, and to be almost confined to these; others, as the common *Unio acutus*, are found even so far down as the mountain limestone shale, and lived on to the close of the coal period with a wide geographical range.

They have been distinguished from the *Unio* of our freshwater lakes and rivers by Prof. King, and though it is as yet by no means certain that they are allied to the *Myadæ*, the character of their epidermis, and the internal position of the ligament that binds the shells together, leads to the belief that they were marine shells.

Anthracosia.—They are thick shells, and yet destitute of hinge-teeth. The modern genera of *Unionidæ* are generally strongly toothed, except the thin *Anodon* and its allies. Again, they have a thick wrinkled epidermis. *Unionidæ* have not this, *Myadæ* have, and the ligament is internal, as in many *Myadæ*. The shape is oval, broadest in front, beneath the beaks.

Anthracomya.—Generally found with *Anthracosia;* differs materially; the shape is broadest posteriorly; the shell thinner; hingeless (so far as known); epidermis wrinkled.

Myalina?—Quadrate shells, slightly inequivalve, but not at all so much so as *Avicula*, and with no produced hinge-line, and no teeth. *Myalina* has an area. Their place is doubtful, and all their analogies are with marine genera. Epidermis not yet observed as wrinkled. These three genera constantly occur in *society*.

If, therefore, we could substantiate the marine character of any one, we should be sure of the rest. And this is the point to which the attention of conchologists should be directed. It is not yet certain that the *Anthracomya* is really allied to the *Mya*, though its want of hinge and wrinkled thick epidermis favours the view. Nor do these shells, or *Anthracosia*, except very rarely, occur with undoubted marine shells, *Producta*, *Spirifer*, or Cephalopodous mollusca.

But then, against the idea of their being freshwater forms, there is the fact that no shells like *Paludina* or *Melania*, or any of the familiar forms in the Purbeck or Wealden deposits, occur in the coal bands. The bivalves were certainly *not* purely freshwater. They were probably not even inhabitants of the open sea. They lived most likely in muddy lagoons of quiet salt-water, and hence the peculiar and marked character of these characteristic coal-shells.

It is desirable that all who may have opportunity, by means of their workmen, of collecting carefully, should obtain these shells in quantity from each seam and locality, and endeavour to ascertain what species are peculiar to each bed. The plants are likely to be more generally spread, and, indeed, we already know more about their distribution.

ON AN ALUMINOUS MINERAL FROM THE UPPER CHALK, NEAR BRIGHTON.

By Messrs. J. H. and G. Gladstone.

The author said that in an old chalk-pit, at Hove, there are many faults, and some of them are filled up with a white mineral that runs along the dislocated layers of flint, and sometimes embeds the shivered fragments. It has the form of agglomerated masses, which are porous, and easily fall to pieces. One piece that was analysed proved to be well defined hydrated bisilicate of alumina—that which has received the name of collyrite—with no other impurity than one per cent. of carbonate of lime. Its specific gravity is 1.99. Another piece contained thirteen per cent. of carbonate of lime, and five per cent. of additional carbonic acid, which must have been combined with the alumina. As the silicic acid was proportionately smaller in quantity, this piece of the mineral was viewed as collyrite in which about half the silicic acid was replaced by carbonic acid.

GEOLOGICAL SURVEY OF TASMANIA.

By C. Gould, Esq.,

The formations treated of were the Upper Palæozoic marine deposits and the coal-measures. The apparent conformability of the two sections was shown, together with their intimate connections, serving to render their consideration inseparable. The coal-measures exist to a greater or less extent through the country, the depth being about nine hundred feet. They may be regarded as constituting two distinct fields, the maximum one, the Mount Nicholas Coalfield, comprehending the various portions developed upon either side of the Break o' Day Valley; the other the Douglas River Coalfield, between Long Point and Bicheno. In the first the position of the principal seams of coal, although highly advantageous to their being worked, is at an elevation of from one thousand two hundred to one thousand five hundred feet above the sea. There were at least six distinct seams in the Mount Nicholas coalfield, one of which was of superior quality and twelve feet in thickness. Since the discovery of the seam, experiments have been made which, though amply sufficient to prove the value of the coal for domestic purposes, and for application to the usual branches of manufacture, have been upon too limited a scale to permit of the determination of its value as a steam-fuel. A remarkable shale exists in the north of the island, available as a source of paraffin and paraffin-oil. The Mersey coal-field was one of very few in Tasmania which is actually worked; for, although the extent of coal throughout the island is almost unlimited, there are very few points at which any operations are conducted.

THE IMPERIAL GEOLOGICAL INSTITUTE OF VIENNA.

Sir R. I. Murchison communicated information from the Director Haidinger, respecting the present state of the Imperial Geological Institute of Vienna. That important institution was one of many which were very likely to have been abolished in the course of the changes which were going on in the empire of Austria. It was founded by Dr. Haidinger, one of the first geologists in Europe, who now wrote that, public opinion having been expressed strongly in favour of the institution, the government had conceded all the terms in favour of geological science which had been formerly granted, and the Imperial and Royal Geological Institute of Vienna was reinstated upon its old foundation.

CARBONIFEROUS LIMESTONE.

By Mr. Richardson, C.E.

Details of the carboniferous limestone, as laid open by the railway-cutting and tunnel near Almondsbury, north of Bristol. There was a branch railway making from Bristol, from the Great Western line, which traversed the Severn. In making this traverse, it was necessary to go across a ridge of limestone, at Almondsbury, the railroad running across that country of carboniferous limestone. On the whole the strata were deep, and subject to very great contortions. In some parts there were broken bands of coal, thrown about in an extraordinary way. The whole of the highly-inclined strata were surmounted by new red sandstone. It was remarkable that there was in this cutting an enormous amount of calcareous and other grit, some bodies of which might be supposed to have formed a regular part of the mountain-limestone. There were also large masses of red substance, evidently formed by concretion.

ON THE GRANITE-ROCKS OF DONEGAL AND THE MINERALS ASSOCIATED THEREWITH.

By R. H. Scott, Esq.

The author gave a short account of a mineralogical tour made by him, in company with Prof. Haughton, the result of which seemed to throw some light on the possible origin of granite. The district visited was Donegal, which county consists mainly of gneiss and mica-slate, and is traversed in a north-east direction by an axis of granite. This granite is of a peculiar composition, containing two felspars, one orthose, but the other not albite, as in the granite of the Morne mountains, but oligoclase—a mineral whose occurrence in the British Islands had only been noticed within the last twelve months. Prof. Haughton, to whom this discovery is due, was unfortunately unable to attend the meeting. The facts were briefly these:—The granite contains oligoclase and quartz, which combination appears to be a proof that the rock never was in a melted condition; as in that case these two minerals would have acted on each other and formed common felspar. It lies in beds corresponding to the general lie of the strata of the country, and in its character is essentially gneissose; and, lastly, at points inside the area of the granite, metamorphic rocks (limestone and slates) are found with their bedding, which is nearly vertical, unchanged. These bands run for a distance in one case of nine miles across the country. The condition of these rocks is very similar to that of the same rocks outside the granite area; and it is a point of great interest to determine how they got there. The solution of this offered by the author of the paper was that the whole of the rocks had been originally stratified, and had been subjected to some actions which had been termed metamorphic. The result of such action was to convert some into granite, some into gneiss, and some into crystalline limestone and mica-schist, without very much altering their relative positions. The possibility of granite being produced by other means than simple heat seemed to them to be proved by the occurrence of felspar in quartz-veins, which are usually admitted to have been filled by means of infiltration. There were several points in connection with these granites which showed a close relation between them and the granites of Norway. The whole question required a careful chemical and mineralogical examination, which could not be concluded for some time. Among the types of rock found in Donegal is a syenite, the felspar of which is oligoclase. The origin of this rock the author is disposed to attribute to the addition of limestone to the granite. A similar syenite occurs at Carlingford, but contains anorthite, a felspar which would result from the admixture of a larger quantity of limestone than is necessary to produce oligoclase, and has been proved by Prof. Haughton to have such an origin. The anorthite-syenite never occurs unless limestone is present in large excess, which is not the case in Donegal. The district described is very rich in minerals, some extremely rare.

ON THE FAULTS OF THE LANCASHIRE COAL-FIELD.

By Henry Green, Esq.

The author proposed to point out a law which appears to govern the direction of the principal lines of fault in the Lancashire coalfield, and to endeavour to show, on the principles laid down by Mr. Hopkins, that this law is a necessary consequence of the forces which produced the upheaval of the coalfield. On the eastern and northern sides the coal-measures are bounded by millstone-grit, which rises conformably far beneath them. The intensity of upheaval along the eastern boundary was certainly great, as might be expected from its proximity to the central upheaval of England, and there seems reason to believe that it increased in magnitude northwards. The force of elevation along the northern boundary seems also to have increased towards the east; since it would appear that the north-eastern was a point of maximum elevation. On the south, the coal-measures pass regularly but unconformably beneath the Permian and New Red Sandstone formations, the boundary-line being deeply indented by faults, along which promontories of New Red Sandstone run up into the heart of the coalfield. That the portion lying between the Upholland and Boundary faults contains the same measures, and has been acted upon by the same forces of elevation as the main body of the coalfield, cannot be doubted; but its position without the basin, and some irregularity in the directions of its lines of fault, lead the author to think that local causes have chiefly determined the arrangement of the measures. It would appear that the elevating forces have acted with greatest intensity along the northerly and easterly boundaries, increasing in each case towards the north-east corner. It appeared also that the western boundary has been a line of upheaval of smaller and more uniform intensity, and that towards the south the amount of elevation has decreased to a minimum. The upheaval-area may be roughly supposed to be oblong in shape, its longer axis running in an east and west direction, and while its southern and western sides remained fixed, its north-east corner was elevated in a vertical direction. As to the extension of lines running north and south across the area, it is evident that it will increase as we recede from the western side; in fact, it varies very nearly as the square of the distance from that side. In the same way the tension of a line running east and west will vary very nearly as the square of its distance from the southern boundary. Thus, over the uplifted area there will be two sets of parallel tensions, the one acting in a north and south direction nearly, and increasing in magnitude from west to east; and the other in an east and west direction nearly, and increasing in magnitude from south to north. The alteration in the shape of the area produced by its extension will make the lines of tension deviate a little from a northerly and easterly direction, so that the angle between them will never be quite a right angle. The author had applied Mr. Hopkins's calculations to the present case, and obtained the following results with regard to the direction of the first formed set of fissures: 1. When the two tensions are equal, a fissure will tend to be formed in a direction at right angles to the line bisecting the angle between them. 2. When the tensions are unequal, in which the tendency to form a fissure is greatest, makes a larger angle, with the direction of the greater tension than with that of the other, this angle tends to a right angle as its bisecting value. Now, since one tension depends only on the distance from the western boundary of the area, and the other on the distance from the southern boundary, the tension will be equal when these distances are equal. Hence, in every part on this line the fissures will tend to run in a north-west and south-east direction. The line just mentioned will divide our area into two parts, a triangle and a quadrilateral. The distance of every part in the triangle from the southern boundary (and hence the easterly tension) is greater than from the northerly one. The difference, too, increases as we go northwards; hence the lines of fracture will tend to change from a north-west and south-east into a north and south direction more and more as we go further north. Similar reasoning will show that in the quadrilateral the direction of the fissures will tend to become more and more nearly east and west as we go towards its north-east corner.

REMARKS ON THE BONE-CAVERNS OF CRAVEN.

By J. H. Burrow, Esq., B.A.

The author said that the cave-remains before the meeting were found mainly in Victoria and Doukerbottom caves, near Settle, Yorkshire. These caverns are but two of a large number which occur in the mountain-limestone, and more especially in the Lower Scar Limestone (of Phillips). They are of various kinds, dry, wet, from a few yards in length to a mile, merely passages, or scooped out into great chambers. Doukerbottom consists of two chambers, with very long passages between them. Victoria Cave, which was discovered by Mr. Jackson, of Settle, has in it four large chambers, close to each other, and before the flooring of clay was washed in, probably forming one gigantic apartment. The general section of the caves is:—First, from a foot to eighteen inches of soil, in which are the bones of recent animals. Second, about six inches of the ancient flooring of the cave, when it was inhabited by man: in this were found all the antiquities which were discovered, and the bones of animals similar to those last mentioned. Third, dense stiff clay of very great thickness, in which no antiquities and scarcely any bones were found. Fourth, the original rocky floor of the cave, resting on which were bones differing in colour, lightness, &c., from the others. The antiquities found in the second stratum were flint implements, adze-heads of stone, sling-stones; of bone—arrow-heads, combs, and pins; shells and wolf's teeth pierced for a necklace. These were evidences that an uncivilized race had occupied the cave; but besides these were fibulæ, armlets, and rings of bronze and iron; and coins of Roman emperors, from Nero to Constantine. The bones found were of recent historic period, animals such as the wild boar and the wolf; but with these were other animals of prehistoric age, the cave-tiger and the cave-hyæna, found side by side with the antiquities; and it has been argued that they are therefore contemporaneous with man. The author, however, showed that their presence in such a position was accidental, and proved too much; for, if these bones were contemporary with the antiquities, they were also contemporary with the coins, which come down to 400 A.D.—a time at which we are certain, from history, there were no such animals in England. The present evidence from these caverns of man's contemporaniety with such animals was not to be trusted.

ON ELONGATED RIDGES OF DRIFT, IN BERWICKSHIRE AND OTHER PARTS OF THE SOUTH OF SCOTLAND.

By Mr. Milne-Home, F.G.S.

Mr. Milne-Home described several examples of these "Kaims" in Berwickshire, Roxburghshire, and other places. He stated that they were so regular as to have the appearance of railway-embankments or fortifications, and that they had often been mistaken for the latter. They were from forty feet to sixty feet in height, and sometimes could be traced for three or four miles. They were found at various heights above the sea up to seven hundred and fifty feet. In examining their internal structure they were seen to consist generally of sand, gravel, and boulders; the latter generally rounded, but also occasionally angular. He adverted to the fact that they are sometimes intersected by rivulets and even rivers, but that notwithstanding this they had all the appearance of having, been when originally formed, continuous. The author offered some remarks on the agency supposed to have been concerned in the production of these "kaims." He repudiated the notion of their formation by glaciers. He considered they were due to the action of water, as indicated by their internal structure; and supposed that they must have been formed by the waters of the ocean when they stood at least eight hundred feet above its present level. The only question, as he thought, was whether they had been thrown up as submarine spits or banks, or whether they had been formed by a process of scooping out, when the land emerged from the ocean. His opinion wavered between these two views, but he was inclined to favour the last, as he thought that the violent action of tides and currents was inconsistent with the layers of fine sand which frequently occurred in the kaims.

REMARKS ON THE TEMPERATURE OF THE EARTH'S CRUST, AS EXHIBITED BY THERMOMETRICAL RETURNS OBTAINED DURING THE SINKING OF THE DEEP MINE AT DUKINFIELD.

By Wm. Fairbairn, Esq., LL.D., F.R.S.

Wm. Fairbairn, Esq., LL.D., F.R.S., said—It is now more than ten years since a series of experiments was commenced to determine the temperature at which certain substances became fluid under pressure. These experiments had reference to the density, point of fusion, and conducting power of the materials of which the earth's crust is composed, and were prosecuted with a view to the solution of some questions regarding the probable thickness of the earth's crust. Contemporaneously with these, we were fortunate in being able to ascertain by direct experiments, under very favourable circumstances, the increase of temperature in the earth's crust itself. These observations were obtained by means of thermometers placed in bore-holes at various depths, during the sinking of one of the deepest mines in England, the coal-mine belonging to F. D. Astley, Esq., at Dukinfield. The bore holes were driven to such a depth as to be unaffected by the temperature in the shaft, and the thermometers were left in them for periods varying from half an hour to two hours. It is very difficult to arrive at accurate data on the subject of the increase of temperature in the earth's crust. The experiments hitherto made give, unfortunately, somewhat conflicting results, and even in the same mine the rate of increase of temperature is by no means uniform. This is shown very clearly in the results obtained by Mr. Astley. It is scarcely probable, however, that the temperature in the mine-shaft influenced the results, and we must therefore seek the cause of this irregularity in the varying conducting power of the different strata, arising from different density, and different degrees of moisture of the strata. As to the rate of increase, they appear to confirm previous experiments, in which it has been shown that the temperature increases directly as the depth. The rate is at first rather less than this, afterwards somewhat greater, and at last again less, but on the whole the straight line on which the temperature increases as the depths nearly expresses the mean of the experiments. The amount of increase indicated in these experiments is from 51 degs. to 57¾ degs., as the depth increases from 5⅔ yards to 231 yards, or an increase of 1 deg. in 99 feet. But if we take the results which are more reliable, namely those between the depths of 231 and 685 yards, we have an increase of temperature from 57¾ degs. to 75½ degs., or 17¾ degs. Fahrenheit. That is a mean increase of 1 deg. in 76·8 feet. This rate of increase is not widely different from that discovered by other authorities. Walferdin and Arago found an increase of 1 deg. in 59 feet in the artesian well at Grenelle. At the salt-works at Rheme, where an artesian well penetrates to a depth of 760 yards, or rather more than the Dukinfield mine, the increase is 1 deg. in 54·7 feet. MM. de la Rive and Marcet found an increase of 1 deg. in 71 feet. In one respect the observations in the Dukinfield mine are peculiarly interesting. As they give the temperature in various descriptions of rock, they appear to prove what has hitherto been partially suspected, namely, that the conducting powers of the rocks exercise a considerable influence on the temperature of the strata. If we add to this the influence of the percolation of water, we shall probably have a sufficient explanation of the irregularities observed in the experiments. From the above observations we have evidence of the existence in the earth of a central heat, the temperature, so far as can be ascertained, increasing in the simple ratio of the depth. We do not, however, presume to offer an opinion as to whether this increase continues to infinitely greater depths than we have yet penetrated, as observations upon this point are still imperfect. But, assuming as an hypothesis, that the law which prevails to a depth of 700 yards continues to operate at still greater depths, we arrive at the conclusion that at a depth of less than two and a half miles the temperature of boiling water would be reached, andat a depth of 40 miles a temperature of 3,000 degs. Fahrenheit, which we may assume to be sufficient to melt the most refractory rocks of which the earth's crust is composed. If, therefore, no other circumstance modified the conditions of liquefaction, all within a thin crust of this thickness would be in a fluid state. This, however, is not the case. At these depths the fusing point is modified by the pressure and conductivity of the rocks. We know that in volcanic districts, where the great subterranean laboratory of nature is partially opened for our inspection, the molten mass, relieved from pressure, pours forth from volcanic craters currents of lava which form a peculiar class of rocks. Besides this, it has been ascertained from Mr. Hopkins's experiments on soft substances, such as spermaceti, wax, and sulphur, that the temperature of fusion increases about 1·3 Farenheit for ever 500lb. pressure per square inch, that is, in other words, that the temperature of fusion under pressure is increased in that ratio. If we assume this to be the law for the materials of the earth's crust, and correct our previous calculations in accordance with it, we shall find that we have to go to a depth of 65 miles, instead of merely 40, before the point of fusion of the rocks is reached. It must, therefore, be observed that Mr. Hopkins's later experiments with tin and barytes, do not show such an increase of the point of fusion in consequence of pressure, and he is led to the belief that it is only in the more compressible substances that the law holds true. Independently of this, however, Mr. Hopkins points out to me that in the above calculation it is assumed that the conductivity of the rocks is the same at great depths as at the surface. In opposition to this he has shown experimentally that the conducting power for heat is at least twice as great for the dense igneous rocks as for the more superficial sedimentary formations of clay, sand, chalk, &c. And these close-grained igneous rocks are those which we believe must most resemble the rocks at great depths below the surface. Now Mr. Hopkins shows that if the conductive power were doubled, the increase of depth, corresponding to a given increase of temperature, would be doubled, and we should probably have to descend 80 or 100 miles to reach a temperature of 3,000 degrees, besides the further increase which investigation may show to be due to the influence of pressure on the temperature of fusion. Mr. Hopkins therefore concludes that the extreme thinness of the crust assumed by some geologists to account for volcanic phenomena is untenable. Calculations on entirely independent data led him to conclude that the thickness did not fall short of 800, instead of 30 or 40 miles. If it be so much, he is further led to believe that the superficial temperature of the crust is due to some other cause than an internal fluid of nucleus. It remains a problem, therefore, which my friend, Mr. Hopkins, is endeavouring to solve, as to what is the actual condition of the earth at great depths, and the relation of terrestrial heat to volcanic phenomena.

Mr. W. Hopkins considered the paper of Dr. Fairbairn merited more confidence than any which had before been given to the public; for no previous communication had so largely taken into account the various circumstances in connection with deep mines, which bore on the temperature of the earth's crust. The condition of the rocks and walls, as well as the water in mines, must necessarily have a varying effect upon the temperature; and these facts had not previously received sufficient attention at the hands of those who had made experiments. One great advantage of the experiments recorded by the President of the Association was that they were made in a mine before it had been worked. The strata of Dukinfield mine were very much inclined, and there was a good deal of water in it. For this reason great caution was needed in working it, because a wet mine gave a higher degree of temperature than a dry mine. Hitherto there had been great difficulty in making observations and experiments in mines. Dr. Fairbairn supposed that 3,000 degrees might be the temperature of fusion. It might be greater for all they knew. He should be inclined to think it was greater. A thickness of 800 or 1,000 miles for the crust of the earth was more consistent with his own observations, and he positively insisted on a greater depth than 100 or 200 miles.

VELOCITY OF EARTHQUAKE-WAVES.

By R. Mallet, Esq., F.G.S.

The experiments which were conducted at the large blasting-operations at Holyhead were undertaken at the joint request of the Royal Society and the British Association. Mr. Mallett confessed that a few years ago he was under the impression that the velocity of the wave-particle of an earthquake, though not the same as the wave-transit, was nearly equal to it. It was only three years ago, on experimenting at Naples, that he satisfied himself that the wave-particle velocity was extremely low. The wave-partical velocity in any ordinary earthquake did not exceed 10, 12, or 14 feet per second, being about that which a body would obtain by falling off a table. The extreme limit of earthquake-wave velocity appeared never to reach more than 80 feet per second. The only example of this high velocity was mentioned by Humboldt as occurring in the Rio Grande, where, during an earthquake, the bodies of men were thrown upon a bank nearly 100 feet high. The shock was in this case vertical, and the force was equal to a velocity of about 80 feet per second. It was a curious fact that the 14 feet velocity at Naples, and 80 feet in this latter case, corresponded with the respective heights of the volcanic mountains.

THE EXTINCT VOLCANOS OF WESTERN VICTORIA.

By Mr. James Borwick, F.G.S.

Mr. James Borwick denominated the south-western part of Victoria and the adjacent portion of South Australia the "burnt fields" of Australia. The country referred to lies chiefly between the slate and granite dividing the diggings and tertiary limestone of the sea-coast, and has an area of nearly half the size of England, extending from the Bay of Port Phillip, near Melbourne and Geelong, to beyond the western border of Victoria, by the Glenelg. The great basaltic plain of the west has few interruptions from the bay to the border, and from the shore to the central range. The basalt is of all varieties, and furnishes in its decomposition the finest soil to the agriculturist. Many rounded lava hills are found on the plateau of the dividing range; and caverns, nearly 500 feet in length, exist in the basaltic floor of the plains. On the south-west side of the great salt-lake Corangamite, there are basaltic "rises." Below are huge barriers from 10 to 60 feet in height, 15 miles long by 12 broad. The ash or tufa has the same appearances as that the author observed at Lake Albano, near Rome, and at Pompeii. It is occasionally sufficiently solidified to be fit for building-stone. Carvings, however, are very commonly made of it in the district. The ash and cinder-conglomerate exist but in one place—the Island of Lawrence, in the Portland Bay. Cliffs of this singular compound rise there to 150 feet. The author's impression is, that the source was a submarine volcano to the south-west—the course of the prevailing wind and current; and that the ashes and volcanic dust were received in some sheltered bay, since raised with the coast. The extinct volcanos are in the form of lakes and mountains. The lakes are depressions usually on slight eminences. Terang, Elingamite, Purrumbete, Wangoon, and Lower Hill are fresh, while Keilambete and Bulleenmerri are salt. The shallow saline lakes of the plains were not former craters. The depths of these lakes are from 50 to 300 feet. The Devil's Inkstand of Mount Gambier is 260 feet. The banks vary from a few feet to 300 feet in height above the water. The circumference varies from a hundred yards to seven miles. The thickness of the ash increases with the distance from the crater, but is always thickest on the eastern side. At Lower Hill, at a quarter of a mile from the bank, on the northern quarter, it is 80 feet deep, while at a mile off, on the eastern side, it is 150 feet. The volcanic hills vary from a few yards to aboet 2,000 feet above the sea-level. The depth of the dry craters runs from 50 fer. to 300 feet. Gambier and Schanck are within the South Australian bordes The former has three fine lakes, the latter is a dry basin, known as the Devil'

Punchbowl. Porndon is a cone of very light cinder. Leura is a broken crater on the edge of the rises, while Purrumbete is a beautiful sheet of water, a few miles distant, which once, as a crater, discharged vast quantities of ash. The other principal volcanos of Western Victoria are Buninyong, Blowhard, Noorat, Gellibrand, Napier, Franklin, Cavern, Shadwell, Lower Hill, Clay, Elephant, Eckersley. No adequate impression can be formed as to the period of the activity of these cones and craters. There is a freshness in most of them, indicative of a comparatively modern date, and the natives have traditions of the eruptions of several of them.

GLACIAL MOVEMENTS ON THE NORTH-WEST COAST OF AMERICA.

By Sir E. Belcher, F.G.S.

Sir E. Belcher said that early in September, 1837, his expedition ran down the coast of North America, between Ports Etches and Mulgrave, in order to fix the position and determine the heights of Mount St. Elias. The icebergs which hung about the coast were much larger than those which he had seen in Behring's Strait, or off the mouth of the fiords in the vicinity of Port Etches. He believed that in Icy Bay the lower bodies of the ice were subject to slide, and that the entire substratum, as frequently found within the Arctic Circle, was composed of slippery mud. In Icy Bay the apparently descending ice from the mountains to the base was in irregular broken masses, which tumbled in confusion. The motion was clearly continuous. As to the causes which operated in producing the constant displacements of the glacier, and the protusion of the bergs seaward, many theories had been proposed. His impression was that, whatever was the intensity of cold under which congelation had taken place, the actual temperature due to the ice was merely that of 32 degrees Fahrenheit, and that self-registering thermometers, properly buried in ice or snow, subject even to the very low temperature of 62 degrees, 5 below zero, on the external skin, only indicated the proper temperature of freezing water. In the very high latitudes of 63 degrees to 76 degrees North, the snow on the surface of the snow-clad elevations furnished sufficient water to undermine the lower beds of snow-ice, and bore a passage to the sea. However firm the crust might be in certain positions, a furious torrent had been at work beneath. Was the conclusion to be that the temperature of the earth must aid in keeping up a temperature sufficiently high to prevent the water hidden from light from congealing? The advance of vegetation was another proof; the ground-willow, saxifrages, and many other plants producing their shoots before light caused the immediate expansion and colouring of the leaf. The earth's temperature, acting on the lower portions next to the soil, aided in facilitating the travel of the slip of the snow-ice of which these glaciers were composed to lower levels. In all ice-formations there might be noticed, at the season which followed the period of day-frost or preceded the spring, a peculiar dryness, the result of evaporation of the superfluous water, attended by dense fogs. An ominous cracking was then experienced, which had been misrepresented by some of the first Arctic explorers as the breaking of the bolts of their vessels: no bolt was ever traced to have been so broken. He imagined that the soil on which masses of eternally-shifting ice reposed, must be, from never being exposed to the sun's rays, of a loose, boggy, or muddy nature, which facilitated slipping. The undermining facilitated cracking, and the very action of alternate freezing and thawing between the exposed surfaces, serving as aqueducts along the upper portions into which water would flow, must produce compact ice; and its power in that very action was quite adequate, by compression, not only to remove ice, but even mountains of earth, provided the *point d'appui* be afforded. It was evident with respect to the lower portions supporting Mount St. Elias, which were subject to a summer-heat which ripened strawberries, and was even more oppressive than we experienced in England, and to rapid thaws of the inferior levels, that repeated fracture and avalanches would occur, and that one must calculate on sudden and tremendous concussive force, by the breaking away of whole ranges and precipitating themselves on the lower strata. His opinion was that the shocks of the avalanches communicated laterally had produced such fractures as had been noticed in those peculiar pyramidical forms near Mount St. Elias. These fractures opened, were filled by water, which probably froze at night or when the sun was absent, and expansion drove the exterior masses, which were termed bergs, into the sea.

DURA DEN.

By the Rev. Dr. ANDERSON, F.G.S.

The Rev. Dr. Anderson stated that last year the Committee of the Association made laborious researches in quest of the long-lost *Pamphractus* of Agassiz, nowhere seen nor heard of in any part of the above-named rocks for a period of twenty-five years. He had now to state that in their latter excavations they had come upon the hidden treasures, and he had the pleasure of laying them upon the table, in a condition of the most perfect preservation. There was a double interest connected with this curious crustacean. First, of a rare discovery; and next, of a successful result in a matter of keen and important controversy. The specimens discovered were five impressions of the *Pamphractus Andersoni*, two of which were perfect in all their plates, whilst the others were more or less mutilated in some of their organisms. Besides this genus, the excavations had revealed at least one other entirely new to science. The specimen of this new fossil, which he laid upon the table, was in a sufficiently good state of preservation for determining all the true characteristics of the genus in scales, fins, plates, and general contour. The caudal and pectoral fins were enormously large, the body short and small, and the head comparatively very large.

SUBTERRANEAN MOVEMENTS.

By Prof. VAUGHAN, F.G.S.

Professor Vaughan, of Cincinnati, stated that the definite relations recently discovered between calorific and mechanical action seemed to have an important bearing on questions relating to the secular refrigeration of the earth and the high temperature of its internal regions, even at the present time. The vast amount of heat supposed to have escaped from our planet during past ages, might be reasonably expected to call into existence forces of much greater efficiency than those indicated by the upheaval of lands, or by the violence of earthquakes and mechanical eruptions. Our terrestrial fabric had a strength too limited for the full development of such great calorific powers by the unequal contractions of its different parts; and in a cooling globe compound gases could not be expected to produce any decided mechanical effect, at least without materially altering the composition of the atmosphere. But, apart from these causes, the transition of the igneous rocks from a fluid to a solid state would be attended with occasional paroxysmal movement and change. Being dependent on hydrostatic conditions for stability, the different parts of the earth's crust must extend into the greater reservoir of lava to a depth in some measure proportionate to the elevation above its surface. Continents must rest on solid foundations far deeper than those which supported the body of the ocean; and the violence which subterranean forces manifested in several islands might be ascribed in part to the weakness of the barriers which restrained them. Inequalities in the solid envelope of our globe were indicated with some certainty by local forces of gravity. The anomalous character of the vibrations of the pendulum, when applied in some places, justified the conclusion that the invisible side of the earth's crust contained the greatest irregularities, and that our continental tracts of land rest on the bases of gigantic subterranean mountains, whose tops might be depressed even three or four hundred miles below the mean level of the solidified matter. The accumulations of solid matter on the internal mountains must ultimately be crushed by the strain which their augmented size occasioned; a mighty avalanche of rock would then tumble to the thinner part of the earth's crust. Regarding these masses as the cause of earthquakes, they might account for the instantaneous manner in which shocks of earthquakes occurred, their extreme violence, and destructive character near the coasts of continents and on adjacent islands, while they were almost imperceptible in the interior of continents. It was probable that the ascending movements of silica, and perhaps of other isolated matter, might serve to bring the heavy metallic deposits from the central to the superficial regions of our planet; and the general occurrence of gold in auriferous quartz-rock might thus admit of plausible explanation.

THE FORMATION OF LAND.

By the Rev. C. R. Gordon, M.A., F.R.S.

The Rev. C. R. Gordon, M.A., F.R.S., proceeded to say that the solid parts of the globe are in general composed of sand, gravel, argillaceous and calcareous strata, or of the various compositions of these with other substances. Calcareous bodies belong to the sea, and are formed in it. There are only two ways by which porous or spongy bodies can be consolidated, either by congelation or attrition. To procure solidity, it must be brought about by inducing fluidity, either immediately by the action of heat, or directly by the operation of a solution. Thus, fire and water may be considered as the general agents in this operation. The strata formed at the bottom of the sea are to be considered, therefore, as having been consolidated either by aqueous solution and crystallization, or by the effect of heat and fusion. We have strata consolidated by calcareous spar. We have strata made solid by fluor, a substance not soluble, so far as is known, by water. We have strata consolidated with sulphureous and bituminous substances, which do not correspond to the solution by water. We have strata consolidated with siliceous matter, in a state totally different from that under which it has been observed, on certain occasions, to be deposited by water, some consolidated by felspar, a substance indissoluble in water, some also consolidated by almost all the various metallic substances, with their almost endless mixtures and sulphureous compositions,—that is to say, we find very different substances introduced into the interstices of strata, from those which had been formed by subsidence at the bottom of the sea. On the other hand, if it is by means of heat and fusion that the loose and porous structure of strata shall be supposed to have been consolidated, then every difficulty which had occurred in reasoning upon the power or agency of water is at once removed. The question then comes, by what means these masses of loose materials collected at the bottom of the sea have been raised above its surface and transformed into solid land. Nothing can be imagined so proper for the elevation of land above the level of the ocean as an expansive power of sufficient force applied directly under these materials. The question is not how the power may be procured, but is it ever employed? It is this, doubtless, which has forced up from a considerable depth of the ocean the Himmalayas, the Andes, or the Alps. And such a power cannot be much less than that required to elevate the highest land upon the globe. When fire bursts forth from the bottom of the sea, as was the case in the new island near Santorini, and when the land is heaved up and down so as overturn cities in an instant, and split asunder rocks and solid mountains, there is no one but must see in this a power which may be sufficient to accomplish every view of nature in erecting land as it is situated in the position most advantageous for such a purpose. In a stream of melted lava which runs down the sides of Mounts Etna or Hecla, we have a column of weighty matter raised an immense height above the level of the sea, and in the rocks of enormous size which were projected from their craters several miles into the air, it must be acknowledged that there is a liquefying power and expansive force of subterranean or violent heat. But that the islands of Sicily or Iceland themselves had been raised from the bottom by the same process may also be readily admitted. If then it shall appear that matter which had once been found at the bottom of the sea, and which in some respects is analogous to lava, is now forming dry land above its surface, it will be allowed that we have discovered the secret operations of nature concocting future land, as well as those by which the present habitable earth had been produced from the bottom of the abyss.

The other papers read were :—

"Notes on two Ichthyosauri," exhibited at the meeting. By C. Moore, F.G.S.

"On the relation of the Eskdale Granite, at Black Comb, to the Schistose Rocks." By J. G. Marshall, F.G.S.

"On the Sandstones and their associated deposits of the Valley of the Eden and the Cumberland Plains." By Professor Harkness, F.G.S.

"On some Phenomena connected with the Drift of the Severn, Avon, Wye, and Usk." By the Rev. W. S. Symonds, F.G.S.

"On the Pleistocene Deposits of the Districts about Liverpool." By G. W. Morton, F.G.S.

"Notice of some facts in relation to the Postglacial Gravels of Oxford." By Professor Phillips, F.G.S.

"Palæontological Remarks upon the Silurian Rocks of Ireland." By W. H. Baily, F.G.S.

"Comparison of Fossil Insects of England and Bavaria." By Dr. Hagem.

"On the Cretaceous Group, in Norfolk." By C. B. Rose, F.G.S.

"Exhibition of New Geological Survey Maps." By Sir R. I. Murchison, V.P.G.S.

"On the Old Red Sandstone of South Perthshire." By Professor R. Harkness, F.G.S.

"On the Aqueous origin of Granite." By Mr. A. Bryson.

"On the Age of the Dartmoor Granites." By W. Pringelly, F.G.S.

"On the late changes in the Physical Geography of British North America, with Notes on the Auriferous Drifts of the Pacific Slope." By Dr. Hector, F.G.S.

"On the Age and Distribution of the Mesozoic Coal of the Pacific Coast and Saskatchavan Prairies." By Dr. Hector, F.G.S.

"On certain Markings in Sandstones." By Mr. W. Patterson.

"Information respecting the present state of the Imperial Geological Institute of Vienna." By Director Hardinger, For. M.G.S.

"On the Details of the Carboniferous Limestone, as exhibited in the railway-cutting and tunnel near Almondsbury, west of Bristol." By Mr. Richardson, C.E.

"Report on Examination of Minerals." By Mr. A. Gages.

"An Examination of some points on the Doctrine of the Internal Heat of the Globe." By Professor W. Thomson, F.G.S.

In the other sections, the following papers were of interest to geologists:—

"On the action of Lime on Animal Matter." By John Davy, M.D., F.R.S

"On the Motion of Glaciers." By W. Hopkins, F.G.S.

"On the Spitzbergen Current, and Active and Extinct Volcanos in South Greenland." By Colonel Shaffner, U.S.

"Notes of Sketches of Parts of the Surface of the Moon." By Professor Phillips, F.G.S.

"Physical considerations regarding the probable age of the Sun's Heat." By Professor Thompson.

"Report on the Theory of the Exchanges of Heat." By Balfour Stewart.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—November 6.—Sir R. I. Murchison, V.P.G.S., in the Chair.

The following communications were read:—

1. "Note on the Bone-Caves of Luniel-Viel, Herault." By M. Marcel de Serres.

These bone-caves, in Miocene limestone, on the Mazet estate, near Montpellier, discovered about 1828, and described in 1839 by MM. Marcel de Serres, Dubrueil, and Jean-Jean, comprise a large cave and some smaller fissures, containing red earth with pebbles, and an abundance of bones and coprolites, of hyæna, lion, bear, wolf, fox, otter, boar, beaver, rhinoceros, horse, deer, ox, &c., with birds and reptiles. The author expressed his belief anew that the association of pebbles with the bones in caves is a common phenomenon, and an evidence of the accumulation of the materials—gnawed bones and coprolites included—by the running water of violent inundations, the caverns being of Tertiary origin, the detritus being contemporary with the old alluvium of the Rhone, and the fauna indicated by the bones having been antecedent to the latter.

2. "On the Petroleum-springs in North America." By Doctor A. Gesner F.G.S.

After some observations on the antiquity of the use of mineral oil in North America and elsewhere, and on the present condition of the oil and gasspins and the associated sulphur and brine springs in the United States, the author stated that 50,000 gallons of mineral oil are daily raised for home use and for exportation. The oil region comprises parts of Lower and Upper Canada Ohio, Pennsylvania, Kentucky, Virginia, Tennessee, Arkansas, Texas, New Mexico, and California. It reaches from the 65th to the 128th degree of long. W. of Greenwich, and there are outlying tracts besides. The oil is said to be derived from Silurian, Devonian, and Carboniferous rocks. In some cases the oil may have originated during the slow and gradual passage of wood into coal, and in its final transformation into anthracite and graphite—the hydrogen and some carbon and oxygen being disengaged, probably forming hydrocarbone including the oils. In other cases, animal matter may have been the source of hydrocarbons. Other native asphalts and petroleums were referred to by the author, who concluded by observing that these products were most probably being continually produced by slow chemical changes in fossiliferous rocks.

3. "Notice of the Discovery of some additional Land Animals in the Coal-measures of the South Joggins, Nova Scotia." By Dr. J. W. Dawson, F.G.S.

Two additional fossil stumps of trees have been examined by the author from the same group of the Coal-measures as that which has already afforded Reptilian, Molluscan, and Myriapodal specimens. These trees stand on the six-inch coal in Group XV. One (*Sigillaria Brownii*) has yielded indications of six skeletons of *Dendrerpeton Acadianum* (one probably perfect), a jaw of a new species, two skeletons of *Hylonomus Lyellii*, one of *H. Wymanii*, a number of specimens of *Pupa vetusta* and *Xolobius Sigillariæ*, and some remnants of insects (in coprolites). In a lower bed (1217 feet beneath,—in Group VIII.), a Stigmarian under-clay, seven feet thick, the *Pupa* was found abundantly in a thickness of two inches—with fragments of Reptilian bones. The coal-seams between the trees and this bed indicate that this *Pupa* must have existed during the growth and burial of at least twenty forests.

4. "On a Volcanic Phenomenon observed at Manilla, Philippine Isles." By J. G. Veitch, Esq. In a letter to Dr. J. D. Hooker, F.G.S.

On the 1st of May, 1861, the River Passig, at Manilla, from fifteen to eighteen feet deep, was disturbed by a violent ebullition from six to ten a.m., for a distance extending to a quarter of a mile. Its temperature here was 100 deg. to 105 deg. Fahr. (elsewhere 80 deg.) A bank of fetid mud was thrown up several feet above the water, and had a temperature of 60 deg. to 65 deg. The Chairman remarked that a bank of mud, 30 feet high, and more than a mile long, had lately been thrown up in the southern portion of the Caspian. He also further stated that he had received a letter from J. G. Medlicott, Esq., of the Indian Geological Survey, announcing that a scientific expedition had been set on foot by the Government of India for the exploration of the great mountains of Central Asia. The expedition is to consist of five men of science, and Mr. Medlicott is to be the geologist. They will assemble early in the new year at Almorah, traverse the Himalaya and Karchan Chains, and, proceeding into Tartary, they will explore the Great Thian-Chan, then passing eastwards, they are to return to Hindostan by the Ganges or the Brahmaputra River. The explorers are anxious to receive any suggestions from the Members of the Scientific Societies of London.

November 20.—1. "On the Bovey Basin, Devonshire." By J. H. Key, Esq , communicated by Sir C. Lyell, F.G.S.

The author first described the physical features of the Bovey Basin, and then the strata, as proved by borings and diggings for clay and lignite. Having pointed out the evidences that exist of the basin having once been a lake in which the several strata of clay, sand, lignite, gravel, &c., were deposited, and having considered the probable conditions of such a lake having been gradually filled up by fluviatile deposits brought down from neighbouring granitic hills, the author remarked:—1st. That the Bovey deposits are composed of materials almost identical with the component parts of granite. 2. The strata run, for the most part, parallel with the outline of the marginal hills, and dip from the sides towards the centre, often thinning away in that direction. 3. The finer material is deposited towards the sides, and the coarser towards the centre. 4. Where the basin is contracted the finer beds often disappear; but thicken where the basin widens. 5. That the upper beds of the northern part are coarser than those of the middle and lower portions. 6. On the eastern side the fine clay beds are more developed than on the western side. 7. The various beds run in the direction of, and seem to point to, the River Bovey as the source from whence they were derived; but the old outlet of the lake was towards Torbay, and not along the Teign as it is at present. Some observations on the peculiar absence of animal remains in these deposits, often rich with vegetable remains, concluded the paper, which was illustrated by several original plans, sections, and sketches.

2. "On two Volcanic Cones at the Base of Etna." By Signor G. G. Gemmellaro. Communicated by Sir C. Lyelt, F.G.S.

These two cones occur at Paternó and Motta (Sta. Anastasia); and the existing remains of their craters and nuclei were described in detail. The author concludes that these two were contemporaneous doleritic volcanic cones, that were formed in the Post-pliocene period, previous to the deposition of calcareous tuff of the vicinity of Paternó: also that they were cones of eruption, and not of elevation; for the neighbouring strata are not disturbed: and thas they were independent eruptions, and not parasitical cones of Etna.

3. "On some Fossil Brachiopoda of the Carbiniferous Rocks of the Punjâb and Kashmir, collected by A. Fleming, M.D., &c., and W. Purdon, Esq., F,G.S." By T. Davidson, Esq., F.R.S., F.G.S.

Dr. Fleming's geological researches on the Salt-range and elsewhere in the Punjâb, in 1842-52, are recorded in the Journal of the Society, for 1853, in the Journ. Bengal Asiat. Soc. 1163, and in his Report on the Salt-range, 1854. The species of Carboniferous Brachiopoda collected by Dr. Fleming and described and figured by Mr. Davidson, are *Terebratula* (vel *Waldheimia*) *Flemingii*, Dav., *T. problematica*, Dav., *T. subvesicularis*, Dav., *Retzia radialis*, var. *grandicosta*, Dav. *Athyris Royssii*, L'Ev., *A.* (vel *Merista*) *subtilita*, Hall, var. *grandis*, Dav., *Spirifera striata*, Martin, *Spiriferina octoplicata*, Sow., *Orthis resupinata*, Martin, *Streptorhynchus crenistria*, Phil., var. *robustus*, Hall, *St, pectiniformis*, Dav., *Productus striatus*, Fisch., *P. longispinus*, Sow., *P contortus*, Sow.

Mr. Purdon's collection comprises, besides several of the foregoing—*Terebratula Himalayensis*, Dav., *Spirifera Moosakailensis*, Dav., *Sp. lineata*, Martin, var , *Camarophoria Purdonii*, Dav., *Productus Purdonii*, Dav. *P. Humboldtii*, D'Orb., *Aulosteges Dalhousii*, Dav., and *Strophalosia Morrisiana* (?) King, var.

Geologists' Association.—The first meeting of this Association for the winter session was held on Monday, November 4, at Cavendish Square, the Rev. Thomas Wiltshire, M.A., F.G.S., President, in the Chair, and was very numerously attended. Thirteen new members were elected.

Professor Morris delivered a lecture "On Coal; its Geological and Geographical position." Referring to the importance of the subject, the lecturer remarked that he need only allude to the facts that the annual production of coal had now reached the enormous quantity of 80,000,000 tons, in addition to which it was estimated that there were 4,000,000 tons of small, which remained useless upon the pit's bank, and that the working of this mineral gave employment to half a million of our male population. This coal was produced from 2,509 collieries in England and Wales, 427 in Scotland, and 73 in Ireland, so that the large area over which colliery operations extended could be in some measure judged of. His subject being the geological and geographical position of coal, he might most conveniently treat of it under two principal heads—first, geologically, and then its geographical distribution.

Assuming that the larger proportion of his audience were acquainted with the geological sequence, he would simply remind them of the division of stratified rocks into Palæozoic, Mezozoic, and Cainozoic, or Primary, Secondary, and Tertiary. Each of these were again subdivided, but it would be unnecessary at present to mention the whole of these sub-divisions. He would for the present direct their attention to the Palæozoic series. In this series was first the Silurian, above which the Devonian, next the Carboniferous, and then the Permian rocks. Professor Morris then proceeded to illustrate by models the mode by which the various strata were deposited, and explained that, owing to the strata not lying horizontelly, and also to the circumstance that some of the series were usually wanting, strata which would otherwise be beyond the reach of human industry, were placed at our disposal. The carboniferous rocks were subdivided into the carboniferous limestone, the millstone grit, and the coal measures proper; but even the coal measures proper did not consist of one solid and undivided bed of coal. The upper layer was usually an imperfect shale, then came a more bituminous shale, and then the coal proper, which was usually also separated by strata of shale of varying thickness. In all the coal formations he might remark that there was positive evidence of there having been vegetable life, and that in the whole of the carboniferons rocks they frequently met with spirifers, goniatites, orthoceratites, nautili, and other marine shells.

Of the vegetable kingdom they met with various descriptions of plants, the size in some instances reaching that which almost entitled them to be called timber trees; the calamite, sphenopteris, sigillaria, pecopteris, and lepidodendron, being, however, the principal, and of the animal kingdom, perhaps there was no representative more interesting than the species of unio. With regard, however, to the substance which they all knew as coal, he might mention that its existence was not strictly confined to the carboniferous series, or or to the palæozoic formation, but that it was found also in the secondary and tertiary formations, in support of which he might refer to the coal fields of Yorkshire, which were of the oolitic formation, and to certain coal fields in India, which undoubtedly belonged to the eocene or miocene age.

Turning to the consideration of the geographical distribution of coal, the Professor pointed out the principal fields from which the coal supply of the world is derived, beginning with the Scotch coal field, and proceeding through the Durham, Lancashire, and Yorkshire fields, as well as the minor deposits between them. He then described the Forest of Dean, Bristol and South Wales fields, referring incidentally to the fact that the coal measures of the latter district is estimated to attain the thickness of 12,000 feet, so that an enormous quantity of the precious fuel must be still at our disposal, even making the most ample allowance for waste, and diminution from other causes. He would here say a few words which might render some slight assistance to those attempting to discover the precise mode in which the coal was deposited.

It was found from the careful inspection of the various coal measures, that in England the western portions appear to present mechanical indications, whilst the eastern portions seemed more to indicate chemical action. In the New World precisely the reverse was the case, the chemical action being evident in the west, and the mechanical in the east. Passing to the European continent, he referred to the small coal fields of Belgium, to the three principal deposits in France, to the fields of Spain and Portugal; and then returning eastward explained the formation of the Prussian and Bohemian coal fields, and described the rich deposits of braunkohle which extends across the German continent.

After a brief reference to the coal fields of Africa, discovered by Dr. Livingstone, he passed into Asia, and described the deposits of coal in India, and then proceeded through Borneo, Lebuan, &c., southward, concluding his remarks on the Old World by describing the coals of New South Wales, Tasmania, and New Zealand. The survey of the New World was commenced by a reference of the coal fields and Albertite deposits of the British possessions in North America. Then the great coal fields of the United States were described, and the subject completed by a brief explanation of the nature and extent of the deposits about Chili and Valparaiso.

On the conclusion of the lecture there was an interesting discussion, in which Messrs. Rickard, T. Rupert Jones, Mackie, Lawson, and Prof. Tennant, took part, and Prof. Morris replied to a large number of questions, but declined, in answer to the interrogatories of Messrs. Lawson and Mackie to state any opinion on the nature of original formation of those highly interesting substances Albertite and the Torbane Hill mineral.

The President announced that during the session excursions would be made to Tunbridge Wells or Hastings, Harwich, Cambridge, or Lewes.

Cambridge Philosophical Society.—October 28. At the annual general meeting of this society, after the election of officers, a paper was read by Mr. Harry Seeley "On the Fen-clay Formation."

Extending under the peat of the fen district, and far beyond, is the great clay formation. It includes the Oxford and Kimmeridge clays, and an intervening clay (replacing the Coral rag) which imperceptibly graduates upwards and downwards into these deposits. It is for this series of strata, ranging from the Great Oolite to the Portlandian beds, that the term Fen-clay or Fen-formation is proposed. The fact of such a succession in some degree interferes with existing views of the division of the lower secondary strata into Upper, Middle, and Lower Oolites; so that henceforth it will probably be found more convenient to abandon those terms, and to speak of the secondary formations below the Cretaceous series, as Lias, Inferior Oolite, Great Oolite, Fen-clay, and Portland-bed. In this district the Fen-clay extends from the line of Peterborough to Bedford, across easterly to the line of Ely and Lynn, within which limits it has been chiefly studied, though known to have an extensive development further south.

The various sub-divisions were worked out in the country around Elsworth, near St. Ives. The village is built on a limestone, to which it gives a name, The Elsworth Rock, which consists of three sub-divisions, an upper and lower rock, and a middle clay which abounds in *Ostrea Marshii*. The rock dips to the south, and maintains its thickness (fourteen feet) unchanged for the three miles over which it could be traced, though at that distance the middle clay is replaced by sandstone.

Passing to the north, another rock is met with, at St. Ives, and this was shown to be 130 feet below the Elsworth Rock, coming out from under it, being brought up by an anticlinal axis, so that further to the north, at Bluntisham, the Elsworth rock is again met with. The St. Ives rock dips to the east, and appears to be found again at High Papworth, west of Elsworth. As the St. Ives rock dips to the east, so will the Elsworth rock also, and therefore the clay to the east and south will be superior to it, while that to the west is inferior. Passing then west to St. Neots, another rock occurs, and this would seem to be very low down in the series, and not far removed from the zone of the Kelloway rock. The St. Neots rock consists of thin layers of limestone, which are alternate with thin beds of clay.

Among the fossils in the Oxford Clay, at St. Neots, are *Ammonites Duncanii*, *A. spinosus*, *A. athlethus*, *A. coronatus*, &c. The commoner forms at St. Ives are *Ammonites Mariæ*, *A. cordatus*, *A. Eugenii*, *A. Goliathus*, &c., &c. Of the *Ammonites* in the clay above the St. Ives rock, no good list is known, but among them are *A. alternans*, and *A. babeanus*. Both at Elsworth and Bluntisham, above the rock, the *Gryphæa dilatata* is found abundantly, and occasionally with it *Ostræa deltoidea*; but to the south the latter fossil is more abundant, so that at Tetworth the specimens occur in equal profusion, and in combination with *Ammonites Achilles*, *Belemnites eccentricus*, *Lima pectiniformis*, *Serpula tetragona*, &c., &c. At Tetworth there is a thin band of rock, as there is also at Gamlingay; at Boxworth, nearly, if not in the same position, there is a rock of the same thickness; and to the east, beyond this the clay seems to graduate imperceptibly up to the Kimmeridge clay of Cottenham.

There is thus a great thickness of strata between the Oxford and Kimmeridge clays, in which the fossils of both those deposits are intermixed, and which represents the Coral-rag. That such a clay did exist might have been inferred from the presence of the Coral-rag at Upware, and its limited extension beyond. The Upware limestone was a coral-reef out in an old sea, and it must have necessarily happened that beyond the narrow limits of the reef a deposit of a different kind would have been forming on the sea-bottom, far more widely spread than the limestone. This formation is named the Tetworth clay.*

A difficult question then arose as to the limits of the clay, for if it were replaced by Coral-rag, it would result that the Elsworth rock would be immediately beneath the Coral-rag on the one hand, and above the Oxford clay on the other, and so would appear to be rather a member of the former series than of the latter. However, the presence of such forms as *Belemnites tornatilis*, *B. hastatus*, *Ammonites vertebralis*, *A. biplex*, *A. perarmatus*, *A. Henrici*, *A. canaliculatus*, *A. goliathus*, &c., were held as conclusive evidence that it ought rather to be regarded as the uppermost zone of Oxford clay. The upper boundary of the Tetworth clay cannot be given with any certainty. And from the want of sections it has not been found possible to subdivide the strata above, as has been done below.

Such is the Fen-clay. The rocks of its lower part do not appear to occur in the south of England, though there are divisions of the clay corresponding to those so strongly marked by their occurrence here. The Tetworth clay has long been known to have an extensive southern development; a portion of it appears to have been mapped by the Geological survey as Oxford clay, just as in one district Mr. Lucas Barrett mapped it with the Kimmeridge clay.

The author concluded by expressing his indebtedness, for much kind assistance, to the Rev. S. Banks, of Cottenham, the Rev. H. Dobson, of Elsworth, to Mr. J. Carter, of Cambridge, and to Mr. J. J. Evans, of St. Neots.

MALVERN NATURALISTS' FIELD CLUB. — The last meeting of this distinguished club of observers of nature in the fields of research, was held at Upton-on-Severn.

The chief feature in the operations of the day was the examination of the

* At the Manchester meeting of the British Association, the name of Bluntisham clay was suggested for it, but as the section there is no longer visible, it has been thought better to name it from a locality where it may be seen and worked.

several drift beds of the Severn Valley, which, from the elevation of the marl bank of Ryall Hill, were explained in a most lucid manner, by Mr. Symonds, and their distinguishing contents mentioned. He first described the formation of the original drifts upon the bed of the primeval sea, and then passed in review the successive gravelly beds, with their contents, the hollowing out of the valley, the estuarine and lake periods, down to the Severn of the present day. He also pointed out how the drift beds at Ryall Hill were identified with those on the western heights, though their continuity had long ago been cut off. In furtherance of the examination, the walk was continued to the Barley House on the side of the Severn, where the river was crossed, and an intermediate drift deposit viewed. The route was then continued to the ancient Manor House of Holdfast, where Mr, Henry Stone exhibited various remarkable bones and teeth from the caverns of Somersetshire. The President said he had received an invitation for the club to go to Warwick in February next, and he thought he might properly give the usual annual address there, when both clubs were together, but it was ultimately determined that Malvern should be selected as a more accessible place than Warwick to most members. Dr. Grindrod offered the use of Townsend House for the assemblage of the club, where he had accommodation for a large audience. The subject of the next year's meetings being introduced, the Rev. R. P. Hill proposed the May meeting to be at Ledbury, examining the country thence to Bromsberrow. This invitation was accepted amidst general applause.

A grant was made to republish the erudite paper of the President, on the Geology of the Worcester and Hereford Railway, from the Edinburgh New Philosophical Journal, that its contents might be more extensively circulated.

Manchester Geological Society.—The twenty-third annual meeting was held October 31st, 1861. E. W. Binney, Esq., F.R.S., F.G.S, Vice-President, in the chair, when the usual reports were read :—

Since the last meeting the keys to the cases in which the collection is kept, have been deliveaed to the Curators jointly with the special Curators of the Natural History Society. The collection is therefoie again in proper custody, and to this extent the Society is reinstated in its rights.

The whole collection has been cleaned and put in order, in which labour great assistance has been received from Mr. James Parker.

The Museum is not so rich in local specimens as it ought to be. As a general collection it is undoubtedly a good one; but with the assistance of the members, it can be made one of the first collections of carboniferous fossils in the country. Attention was particularly directed to the Peel Delph, and other localities where the Peel building stone is quarried, for the purpose of collecting the fossil plants with which this rock abounds. They are not compressed and flattened as is the case in most sandstone rocks, and as specimens, are not excelled by those of any other coal-field.

The collection is destitute of Lancashire Silurian fossils, and very poor in Permian, Triassic and Pleistocene specimens.

Tha report expressed the hope that the Council for the ensuing year, and the members will obtain the *desiderata* mentioned, and thus make the collection as complete and instructive as so important and populous a city of Manchester requires.

Since the last annual meeting the society has continued, as for a few years past, to increase in numbers, no less than twenty-seven new members having been admitted in the course of twelve months.

During the past Session the following papers were read before the Society :—

1. "Observations on Down Holland Moss." By E. W. Binney, Esq.

2. "On Jelly-peat, a kind of Peat found at Churchtown, near Southport." By E. W. Binney, Esq.

3. "On the Geological Maps of Lancashire." By Edward Hull, Esq.

4. "On the cause of the Explosion at the Hetton Colliery." By Joseph Dickenson, Esq.

5. "On a Mineral Spring in Germany which is influenced by the pressure of the Air."

6. "On the Geology of Castleton." By John Taylor, Esq., Jun.

7. "Notice of the Life of the late Mr. Elias Hall, the Geologist." By E. W. Binney, Esq.

8. "On the Drift Deposits found about Llandudno." By E. W. Binney, Esq.

9. "On Sigillaria and its Roots." By E. W. Binney, Esq.

The communications and discussions on the safety-lamp; on sudden outbursts of fire-damp; on ventilation in mines; and on other subjects of a kindred nature, have, there is reason to believe, done good by awakening inquiry, and stimulating practical men to the exercise of habits of vigilant and accurate observation.

No excursions were undertaken in the course of the past year. In some of the previous years there were occasionally pleasant and instructive rambles, by parties of the members, into localities presenting Geological features of an attractive kind; and the Council thought it worthy of consideration whether a system of periodical excursions should not be arranged and put in practice, as one of the means for keeping up a lively interest in the Society, and for promoting the objects for which it was instituted.

Another means, not yet adopted, has been suggested as likely to be productive of good in the Society—the holding of evening meetings at the Museum, for the purpose of conversation, and for hearing short lectures explanatory of different groups of fossils in the collection.

The Council urged the desirableness of considering the suggestion about making the Society more of a mining institute than a Geological Society—the improvement of mining being one of the objects of the Society.

Joseph Dickinson, F.G.S., was elected President.

The routine business having been gone through—

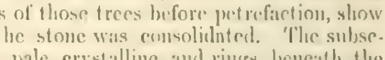
Mr. Edward Lacey exhibited two specimens of lead ore (galena) from a vein which cuts, in nearly a vertical direction, through a coal at Axe Edge, Derbyshire. The coal is sixty yards above the limestone, and, where in contact with the lead, it is not charred nor altered in any way—clearly showing that the lead was not introduced in a heated state. The vein of galena is about three inches in thickness, and is contained in a fracture of the strata, or fault, which passes through the rocks above and below the seam of coal. It has been followed about fifteen yards above the coal, without presenting any indication of swelling out to a workable thickness; but at present it has not been examined below the level of the coal on account of the accumulation of water in that direction.

Mr. Binney stated that he had described a similar vein found in Mr. Gisborne's colliery, at Horwhich, near Whaley Bridge. The strata there and near Axe Edge were in the same geological position—namely, the Rothdale series of coals. The bed of coal where the lead was found might be only sixty yards in horizontal distance from the limestone, but in vertical distance it would be near two thousand feet. The Whaley Bridge vein is described in his paper in the "Memoirs of the Literary and Philosophic Society of Manchester."

NOTES AND QUERIES.

Fissures in Portland Strata.—In your review of the proceedings of the Geologists' Association, in your last November number, you have noticed some remarks of Mr. Gray on the bone fissures in the Isle of Portland. I do not think you have quite caught the meaning he intended to convey.

The Island of Portland consists of a base of Kimmeridge clay, covered by by strata of Portland sand and Portland oolite, and capped in some parts of the Island by a few feet of calcareous slate belonging to the lower Purbeck. Fissures occur in the oolite, caused apparently by the shrinking of the stone in the act of consolidation. There is an excellent woodcut representing one of these fissures in Mr. Damon's "Geology of Weymouth and the Isle of Portland," page 73. It will there be seen that the fissure affects all the beds beneath the dirt bed, as far as the sand. Now, the facts that the roots of the trees which grew in the dirt bed penetrated the stone beneath, and that the calcareous slate was deposited around the stumps of those trees before petrefaction, show that the slate was deposited before the stone was consolidnted. The subsequent shrinking of the stone, which is pale, crystalline, and rings beneath the hammer, seems to have caused the fissures in the stone beds that do not pass upwards into the calcareous slate. Not that the slate has not likewise contracted in hardening, but its contraction has caused a multitude of small interstices at short intervals, whilst the interstices between the blocks of solid stone have occurred at greater distances from each other, and, therefore, taken singly, are of greater width, and have no corresponding fissures above them on the slate. Now, what Mr. Gray means with respect to the human bones, which have been occasionally found in the fissures, is this—viz., that they have only been found in those parts of the Island which are capped by the calcareous slate, and not where the stone is immediately subjacent to the vegetable soil.



From what you have quoted from his paper, I would conclude that, where this is the case, the fissures are not vacant, as in the other parts of the Island, but filled with rubble from above, and, therefore, parts of skeletons interred above them would not fall down into them.

Mr. Damon has expressed the same opinion as Mr. Gray—that the human bones in these fissures have fallen from graves in the soil above. He says they "are interred remains, and found a few feet beneath the surface in the rubble bed (that is the calcareous slate), though a stray bone or two may find its way down a fissure where the bones of these animals may have been deposited." (p. 130).

Of course this does no more at the most than show that no fossil remains of man have hitherto been found in Portland, but in no respect affects the question—whether or not they have been found elsewhere?

There are some curious questions connected with the occurrence of mammalian bones of fissures in small islands like Portland and the Isle of Caldy-at which latter place they occur in carboniferous limestone. It seems impossible that the animals to which they belonged (the Elephas primigenius occurs at Caldy) could have lived on such small islands. On the other hand, there is evidence that the general *contour* of this country is only *slightly* altered since the period in which they lived. There appears to be two probable solutions to this difficulty. Either the islands were connected with the mainland by the general surface being higher than at present, and the animals were enabled to roam over what are now small isolated spots, or else the bones are those of carcases floated by the sea, or drifted, along with other deposits, into the fissures, at a time when the land was lower than at present. It is, no doubt, a fact that the land was higher when the great mammals lived—witness the forests which harboured them, now stretching beneath our shallow seas;—and, on the other hand, it is unquestionable that it was also lower not long after their extinction, if, indeed, their extinction was not due to that very cause, for we find their bones buried in the drift of such a period of submergence.

It seems to me that the latter has been the true cause of their deposit in fissures, because many such bone-bearing fissures do not partake of the character of caverns. Those at Portland that I have seen are too narrow to have served as dens. The bones in them are not gnawed as at Kirkdale and other larger caverns. Nevertheless, bones of boar, ox, deer, horse, wolf, sheep, and other numerous smaller animals, most of which do not frequent caverns, occur at Portland.* But still there is a difficulty as to how the bones got into the fissures at Portland, because they are not, and never were, open from above. Is it possible that at the time of the sinking of the land, their ends were exposed in the perpendicular limestone cliffs, now far raised above high water mark, but then subject to the dashing of the waves? Carcases floating on the water would almost inevitably be many of them washed into such fissures, and carried far beneath the undisturbed roofing of slate where they were found. It would be well worth while for those geologists who live upon the spot, to investigate he possibility of this solution.—Yours, &c., OSMOND FISHER, F.G.S.

DEVONIAN AGE.—DESCRIPTIONS OF PLATES V., VI., VII., VIII., AND X.—The subjects of these plates which illustrate Mr. Pengelly's article on "The Devonian Age of the World," are as follows:—

Plate V. *Sphærospongia tesselatus,* showing internal structure from the Limestone of Woolborough, near Newton Abbott, South Devon.

Plate VI. Ichthyodorulite from the Chloritic Slate of Love, Cornwall.

Plate VII.—Fig. 1. *Trimerocephalus lævis* (perfect) from Volcanic Ash, at Knowell, near Newton Bushell, South Devon.

Fig. 2. Tail and Head, with Eyes of *Bronteus flabellifer* from the limestone at Woolborough, near Newton Abbott, South Devon. This specimen is figured in Decade X. of the Geological Survey.

Plate VIII. Trimerocephalus lævis, from Volcanic Ash, Knowle, Newton Bushell, South Devon. This species is figured in Decade XIX. of the Geological Survey. The figures represent the two halves of the same slab showing in Fig 1 the body in relief with the *impression* of the head, in Fig. 2 the head in relief with the *impression* of the body. The purpose is to exhibit the reversal of parts under which singular conditions these fossils are almost invariably found.

Plate X. (Frontispiece).—Fig. 1. Orthoceras, apparently not distorted with siphunculus forming a discontinuous line. From the limestone of Teignmouth.

Fig. 2. Orthoceras, probably distorted, showing a twisted outline, oblique, septa and siphunculus forming forming a discontinuous line. From the limestone, at Oddicombe, near Torquay.

* Damon, p. 130.

Additional Note on the Geology of Biarritz.—Biarritz is built chiefly on a soft sand, passing sometimes into a clay apparently of fresh water origin. These beds are very loosely composed and appear to have been much distured by subsidence and slight landslips, they rest unconformably on a sandstone-rock abounding in the nummulitic fossils, also in echini and shells. Going south from Biarritz, that is towards the Spanish side, you find the sandstone-rock passing into a blue clay. The sand rock overlies the clay; at their junction there is much disturbance, but it is clear that the blue clay underlies the sandstone. This is well seen between Vieux Port and the Basque sands. From the point where the blue clay cliff begins it is very regular in its structure. It continues for at least a mile, dipping uniformly throughout that distance to the north-west at an angle of 45 degs.; the lines of stratification are well defined by bands of stone (a sort of clay stone) lighter in colour and harder in texture than the mass of the cliff, the clay of which is soft and much worn into furrows by the weather, and by the little streams which flow down it. Here and there the cliff is capped with beds of sand lying horizontally on regular strata of yellow, white, and pink colour, much resembling the tertiary sands of Alum Bay in the Isle of Wight.

At the end of these clay cliffs which gradually sink down to the shore, you find first recent sand-hills, and a little further beds of sand like those which cap the cliff, lying horizontally. Where first they appear low down thus on the shore, they are from fifteen to twenty feet high. The uppermost beds are of yellow and brownish sand mixed with pebbles; beneath these is a band of orange-coloured clay about three inches thick, very clearly defined, and immediately below it a dark clay passing downwards into dark brown, and sometimes almost black vegetable matter. This, when dry, splits into thin layers like card-board, it is full of roots and of stems of fir trees; I also found impressions of seeds and fir cones, besides masses of leaves of water plants. This bed varies from a few inches to several feet in thickness. Further on a dark iron-grey sand appeared beneath this bed, but this was only at one point. Going still south the cliff rises again (after an interval of about half a mile) and attains an average height of about forty feet. Here it is composed of the horizontal sands, only with the band of orange clay and the fresh water vegetable bed beneath as the base of the cliff. This continues for about a quarter of a mile, and then the blue clay of the cliff near Biarritz reappears under the horizontal sands, dipping as before at a sharp angle, but not so uniformly. At one point its beds are thrown up quite edgeways, and the nummulitic sandstone-rock appears intruding beneath it, through the sea-shore sand. The clay rests against the sandstone as if the latter had been forced up against it. Here there is abundant evidence of great disturbance.

Not many yards beyond where the sandstone first appears, it appears again so different in texture, that it could hardly be recognised as the same rock, were it not that it is rich in nummulite like the softer rock. In the second instance the soft, yellowish sandstone has been changed into a hard, white, and shining rock, and where the clay rests against it there is a good deal of crystalization, and the clay has been changed into a rich, pinky brown. All the clay here is much more disposed to be shaly than it is near Biarritz, and is harder in consequence.

Nearer the water at this point, especially at low tide, are several beds quite perpendicular, of which the edges only obtrude; they appear of a hard and beautifully coloured rock, quite without trace of fossils. Near it I observed some masses of a very dark green amorphous rock; this is the rock called by Mons. Guidres (page 14 of his little work) *Ophite*.—Yours, &c., A. D. Acworth.

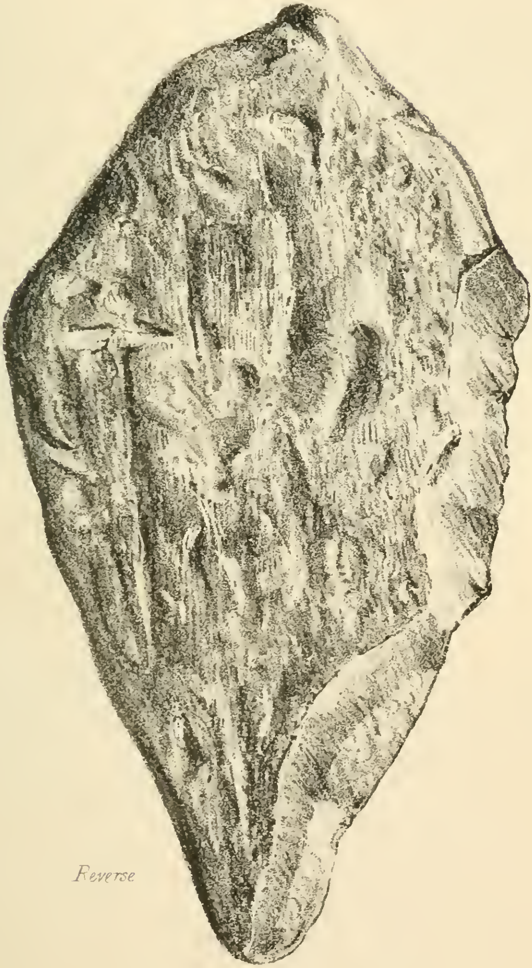
Errata in Sir R. I. Murchison's Address to the Geological Sec-

Front View

BONE SPEAR-HEAD (?)

In the Collection of Mr Mortimer
Malton, Yorkshire

Sketched on Stone from the Specimen by S. J. Mackie F.G.S.



BONE SPEAR-HEAD (?)

In the Collection of Mr Mortimer
Malton, Yorkshire

Sketched on Stone from the Specimen by S. J. Mackie F.G.S.

TION.—Page 441, line 15 from top, for "merely" read "*mainly*;" line 28 from top for "Barkley, it" read "*Barkly, and.*"

ERRATA IN "FOSSILS OF NORTH BUCKS."—Page 483, for "gryphæa" rostrata read "*glyphæa*" rostrata; page 486, for "sphærodus" read "*sphærodus (?)*;" page 485, 2nd line, for "Gryhurst" read "*Gayhurst*;" page 487, for "Cardium dissimile" read "*C. cognatum*;" and, the same page, for "Pecten arenatus" read "*P. arcuatus.*"

BONE SPEAR-HEAD.—Of the bone spear-head of which we have given two views in Plates 13 & 14, we have less to say than we could wish. Its history is very short, and not so satisfactory as one could wish it to have been, although the state and appearance of the fossil itself leaves no doubt of its stratigraphical age.

Mr. Robert Mortimer, of Timber, by whom the specimen was sent to us, thus writes of it:—"I can only state at present that the specimen was picked up by my brother, Mr. J. R. Mortimer, about three years ago, along with a lot of shark's teeth, from a large heap of coprolite belonging to Messrs. Rhodes, Smith, and Co., of Selby, manure manufacturers. The coprolite was from Essex, but I cannot give the exact locality, nor any section showing the bed it came from."

This is all that is known about it, and it would be well that geologists in the vicinity of any of the Essex, Suffolk, or Norfolk coprolite pits should make close search for other examples.—[ED. GEOLOGIST.]

REVIEWS.

North British Review for 1861.

We have, on former occasions, more than once referred to Sir Roderick Murchison's late successful elimination of the key-stone to Scottish Geology. For years upon years the mighty masses of gneiss, sandstones, limestones, schists, and slates were attacked persistently and elaborately by Macculloch, and, Nicol, Jamieson, and other first-class minds without avail. In his early manhood Sir Roderick, accompanied by another of our best workers in Paleozoic Geology, walked over and sketched the massive strata of his native Highlands, which again, after his long-laboured and most persevering exertions in accomplishing the establishment of his Silurian formation, after his forty years of active service in the cause of that one great and interesting group which he has raised to a pre-eminence of elaboration unattained by any other section of the great Past, his mind has returned to his native land, and with the experience of an active life to guide his still persevering energies, he has snatched its crowning glory from the spot which of all others must be most dear to his heart. Of the labours of Mucculloch little is known to ordinary British geologists, except by a few quotations and woodcuts in the popular works of Lyell and others. But if Muccolloch, Nicol, and others failed it was because they were mineralogists and not geologists. It would not be sufficient for a man to distinguish readily the various qualities of papers of which the books of a library were composed, if he were ignorant of the value and meaning of the letters which were printed on their leaves. So the former Scottish geologists, although prying with the utmost minuteness in the study of the mineral characters and conditions of the Scottish strata, missed the true history of their formation in not learning the value and meaning—indeed even the existence—

of those geological letters,—the fossil remains of extinct animals, in which that history was imprinted.

Novel information is necessarily scattered and diffused; one portion is read or delivered to one learned society, another to another on different occasions. Some parts are printed in some of the public journals, some spoken on public or private occasions, and it is usually only after the lapse of at least some few years that a new book or a new edition of an old one gives to the world the portraiture of the investigations in their totality.

The article on "Recent Discoveries in Scottish Geology" in the August number of our excellent contemporary, the *North British Review*, gives an admirable epitome, by a writer well versed in in the most perfect knowledge of his subject, of the entire series of geological advances made from the date of the publication of Macculloch's "Geological Map of Scotland" in 1732, to Murchison's first "Sketch Map" of 1860, and his valuable communications to the London Geological Society in 1861. Our space will not permit us to give an epitome of this valuable article or we should gladly do so, as it is one of such value that everyone interested in Scottish Geology must become acquainted with it if he would understand as he ought to do the value of the recent labours of Sir Roderick Murchison and of Mr. Geekie, Professors Ramsay and Harkness, and other able geologists who have so well and properly supported his novel and important views.

Mr. Gregory's Elementary Geological Series and Collections.

We have just inspected some elementary collections of minerals, fossils, and rocks, which are issued at a very low price; these are the best we have seen for neatness of arragement, while the specimens are very characteristic of the subjects they illustrate. Mr. James Gregory, who has prepared these collections and who has a number of others of larger size specimens, is well versed in mineralogy, so that the names and localities can be depended on for correctness. The rocks especially have a very neat appearance, and we never have seen a a more complete British series. We understand they have been collected personally by Mr. Gregory in each locality.

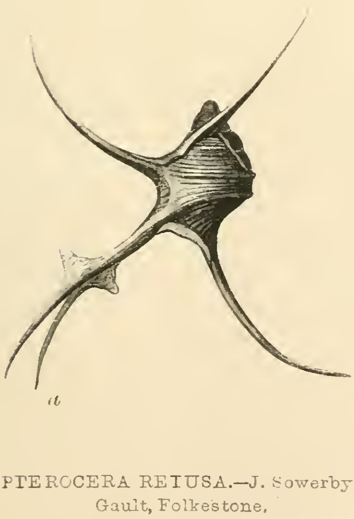
One advantage of these collections is that they can be obtained without cabinets, and this we consider of great importance, as students can thus form a nucleus of a collection at a small cost and not be burthened with a small useless article, which they cannot enlarge nor probably dispose of.

We would also call attention to the series of British fossils, which may be had in small sets, in the same way, of from five to ten or one hundred specimens, each with name, formation, strata, and locality attached; these series are remarkably good and cheap; the prices being considerably under the usual charges. We have seen sets from the Red Crag, Hempsted Bed, Upper Headon, Lower Headon, Barton, Upper Chalk, Portland, and Permian strata, and we believe Mr. Gregory is preparing others from the other British strata. Some of the collections are so light as to be capable of transmission by post for a few pence over the cost by rail, so that collectors in the country, through these series have a cheap and easy method of obtaining deficiencies in their collections, and recognizing species of fossils by actual examples. Mr. Gregory's museum is nicely arranged, and contains a large and select collection of minerals and fossils easily accessible for the selection of single specimens.

Fig 1.

ROSTELLARIA CINGULATA.—S. P. Woodward.
N. sp.
Gault, Folkestone.

Fig 2.



PTEROCERA RETUSA.—J. Sowerby.
Gault, Folkestone,
From Specimens in the National Collection, British Museum.

S. J. Mackie Del. S P. Woodward Direxit.

INDEX.

E.

F.

N.

O.

LIST OF WOODCUTS.

LIST OF PLATES.

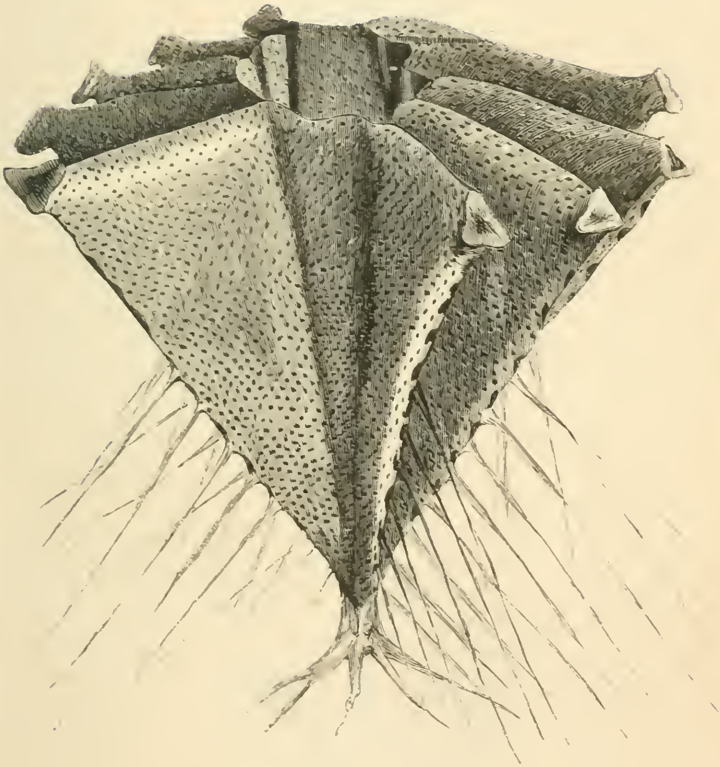
ERRATA.

In Professor Ramsay's 'Glaciers in Wales,' page 531, line 3, *hare* for *has*; line 6, *secondhand* for *second and*; line 13, *deviation* for *elevation*; line 31, *ideality* for *identity*; last line, *Colonie* for *Colonne*.

BRACHIOLITES [illegible]

[illegible]

(Upper Cretaceous Formation)



BRACHIOLITES ANGULARIS.

(Toulmin Smith.)

[Upper Cretaceous Formation.]

Fig. 1.

BRACHIOLITES TUBEROSUS.
(Toulmin Smith.)

Fig. 2.

BRACHIOLITES TUBULATUS.
(Toulmin Smith.)

[Upper Cretaceous Formation.]

Fig. 1.

Fig. 2.

BRACHIOLITES FOLIACEUS.
(Toulmin Smith.)

BRACHIOLITES CONVOLUTUS.
(Toulmin Smith.)

[Upper Cretaceous Formation.]

BRACHIOLITES RACEMOSUS.
(Toulmin Smith.)

[Upper Cretaceous Formation.]

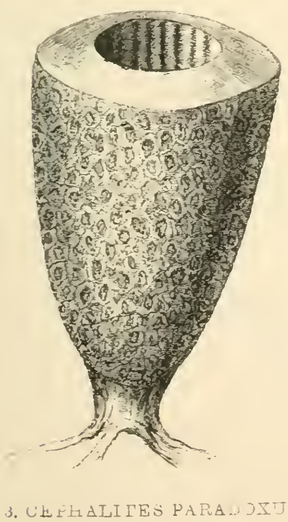
1.

1. CEPHALITES BENETTIÆ.
(Mantell's sp., T. Smith's Figure.)

2.

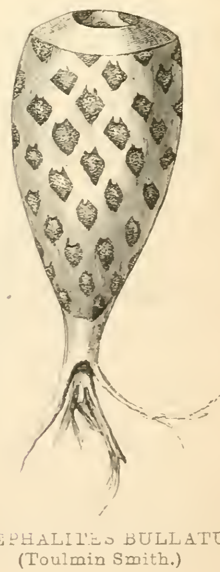
2. CEPHALITES LONGITUDINALIS.
(Toulmin Smith.)

3.



3. CEPHALITES PARADOXUS.
(Toulmin Smith.)

4

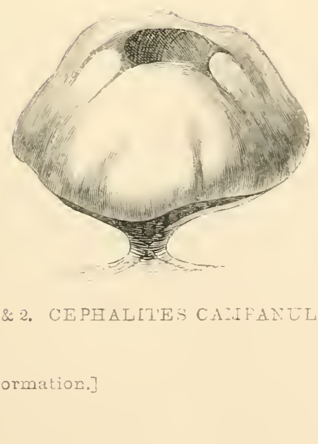


4. CEPHALITES BULLATUS.
(Toulmin Smith.)

[Upper Cretaceous Formation.]

1.

2.



Figs. 1 & 2. CEPHALITES CAMPANULATUS.

[Upper Cretaceous Formation.]

Fig. 1

CEPHALITES CAPITATUS.—Toulmin Smith.

Fig. 2

CEPHALITES COMPRESSUS.—Toulmin Smith.

Fig. 3

CEPHALITES CONSTRICTUS.—Toulmin Smith.
(Syn. *C. Subrotundus*, Mantell.)

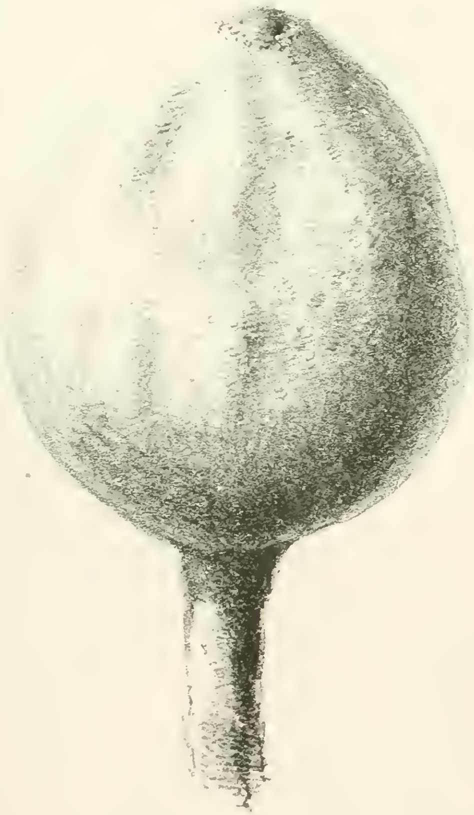
[Upper Cretaceous Formation.]

CHENENDOPORA COMPLEXA, (Benett sp.)

(Cretaceous Formation.) (Upper Greensand)

POLYPOTHECIA FISSA. (Benett.)

(Cretaceous Formation.) (Upper Chalk.)



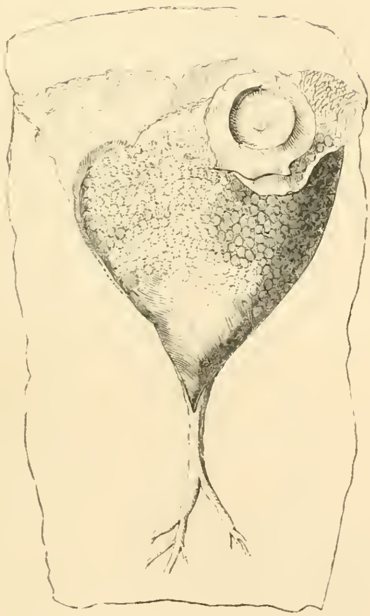
SIPHONIA PYRIFORMIS (Berett [illegible])

(Cretaceous Formation) (Upper Greensand)

SPONGIA RAMOSA (Mantell)

(Polypothecia clavellata (Benett.)

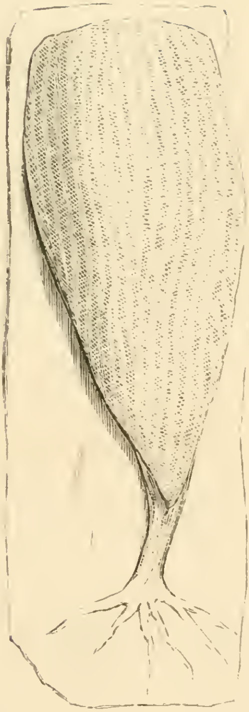
(Cretaceous Formation.) (Upper Chalk.)



VENTRICULITES IMPRESSUS.

(Toulmin Smith.)

S. J. Mackie Del.



VENTRICULITES DECURRENS.—Var. Tenuiplicatus.

(Toulmin Smith.)

[Upper Cretaceous Formation.]